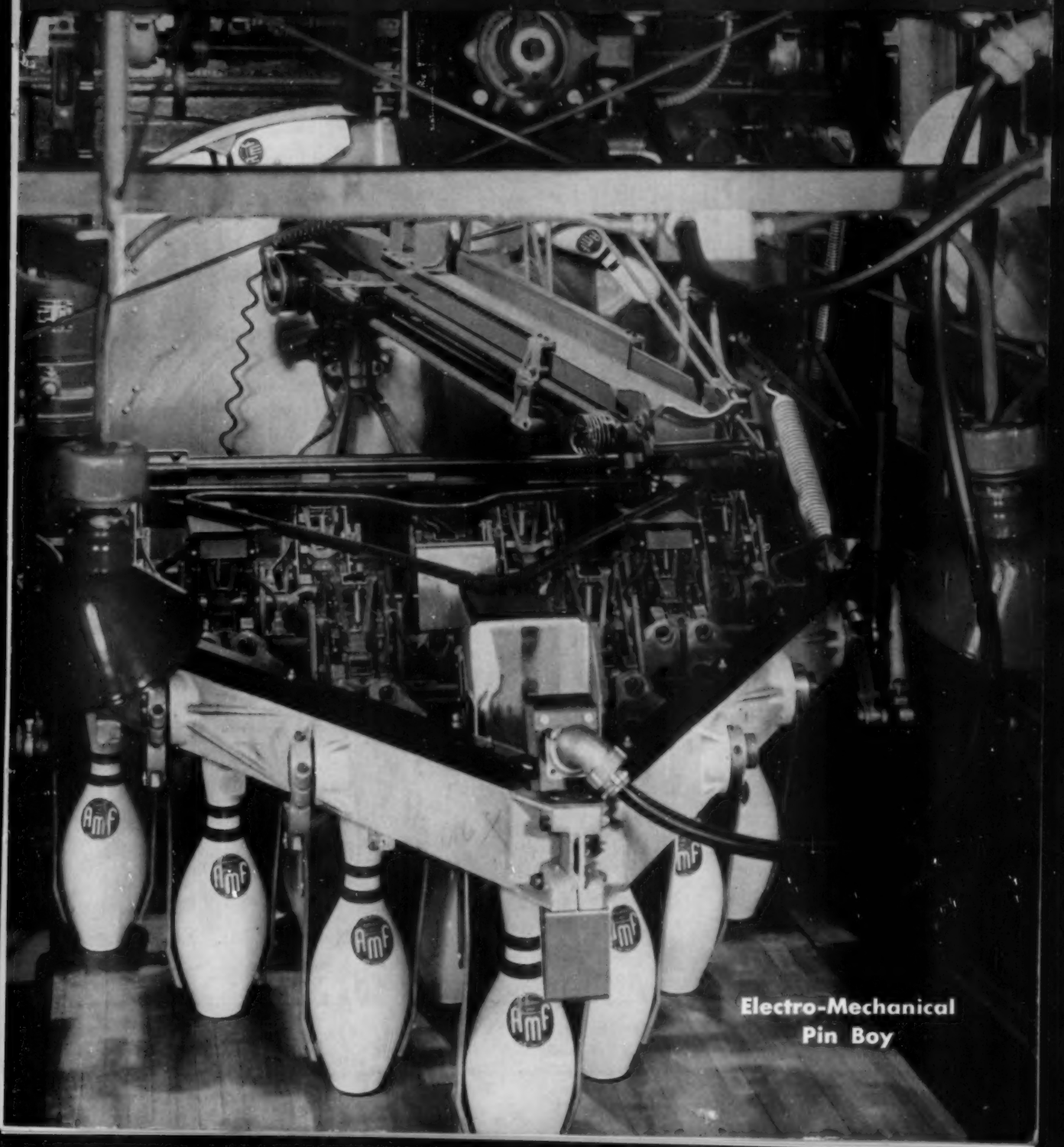
Product Engineering

THE McGRAW-HILL MAGAZINE OF DESIGN ENGINEERING • FIVE DOLLARS A YEAR

JUNE 1954



Electro-Mechanical
Pin Boy

CONTROLLED LUBRICATION ?
in seals and packings

Certainly!

Lubrication through the sealing or packing member can now be controlled precisely. Conpor is the first material that permits complete porosity control for lubricant, solvent, hydraulic and pneumatic application—and at the same time has flexibility, strength, stability, oil and solvent resistance, and greatly increased service life. The result of a six-year development program, Conpor is specially tanned mechanical leather impregnated with liquid polymers.

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Complete leakage control; many times the service life of previous sealing and packing materials; less shaft scoring from oil seals; less waste of horsepower; permits designing for lower torques; eliminates all the faults of previous mechanical leathers, providing stability and a broad resistance to lubricants and solvents; reduces original costs in most cases, and always gives greater economy in service.

Our engineering service will be glad to work with you in developing *Conpor* sealing products for your applications.

C/R
conpor
CONTROLLED POROSITY
SIRVIS MECHANICAL LEATHER

See Sweet's Product Design File $\frac{\text{Ie}}{\text{Ch}}$

Send for this! *"Report on Conpor" gives all basic information on this vital new material. Write: Mr. A. S. Berens, Chicago Rawhide Manufacturing Co., 900 North State, Elgin, Illinois.*

CHICAGO RAWHIDE MANUFACTURING COMPANY

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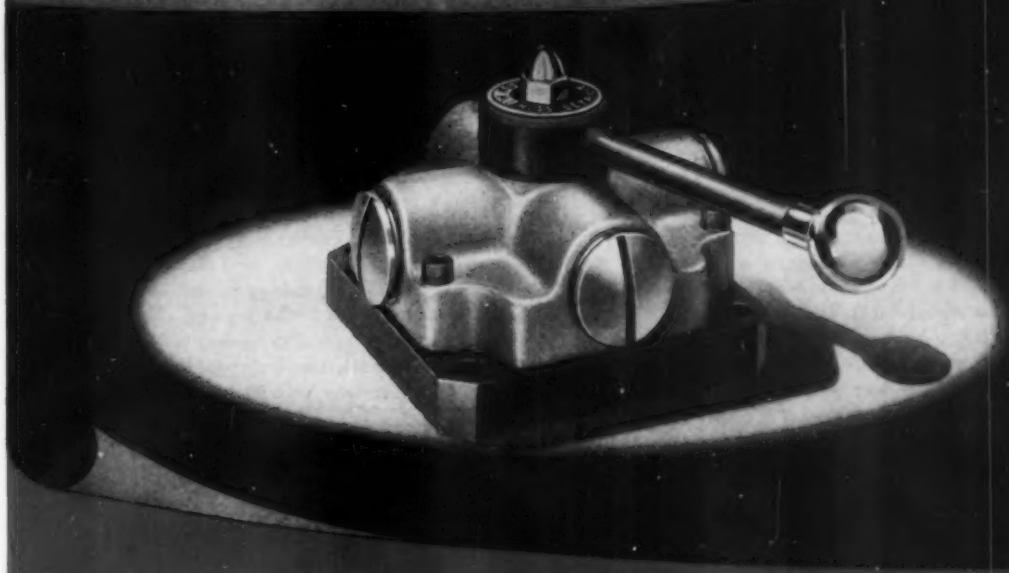
Oil Seals: Shaft and end face seals for all types of lubricant retention and dirt exclusion • Sirvene (Synthetic rubber) diaphragms, boots, gaskets, and similar parts for critical operating conditions • Sirvis: Mechanical leather packings and related products.

IT'S NEW . . .

IT'S FOR MACHINE TOOLS . . .

it's a "pancake"—2" high



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ROSS OPERATING VALVE COMPANY

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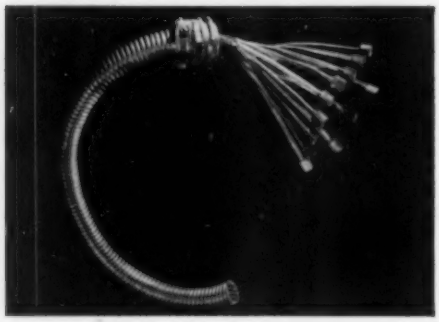
For the new pneumatic instrumentation

Cabled Tube

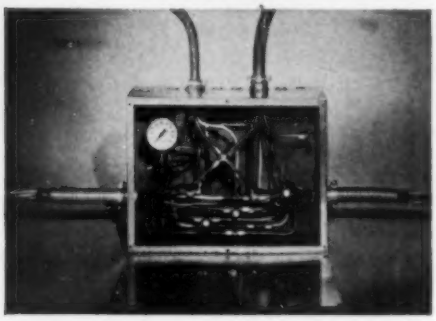
The recent tremendous increase in the use of tube instead of wires for instrumentation and control purposes has led to an important new development—cabled tube. This is an armored group of long tubes twisted together to permit bending without distortion. An insulating tape is wrapped over the bundle of tubes to prevent electrolytic action. Then interlocking, flexible galvanized steel armor is applied, like BX. This protetts the tubes from injury during shipment, storage, installation, and in service. Standard fittings, boxes and cabinets can be used for junction boxes and terminations. To make it possible to readily identify each tube, one tube in each layer is colored; the position of each tube in each layer in relation to the coded tube



remains the same throughout the length of the cable.

The tubes usually are copper, but aluminum tubes can be used for special purposes. For unusually corrosive situations, a plastic outer sheath can be applied. As many as 19 tubes, ¼" OD, can be cabled, and supplied in lengths up to 1,000 ft.

Since the tubes carry not electricity but air, nitrogen, helium, or a fluid, they are especially attractive in potentially explosive locations, as in refineries and chemical plants. Utilities are also turning decisively to this new cable, while automatic process control (automation) is a rising application.



Revere, as a supplier of tube for this purpose, calls this cabled tube development to your attention as a matter of general and perhaps specific interest. See Revere for copper, aluminum and brass tube and pipe, electric welded steel tube, and lockseam tube. Call the nearest Sales Office.

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SEE REVERE'S "MEET THE PRESS" ON NBC TELEVISION, SUNDAYS

Showing the construction of Crescent Armored Multitube, made by Crescent Insulated Wire and Cable Co., Trenton 5, N. J., which will supply further information on request.

Product Engineering

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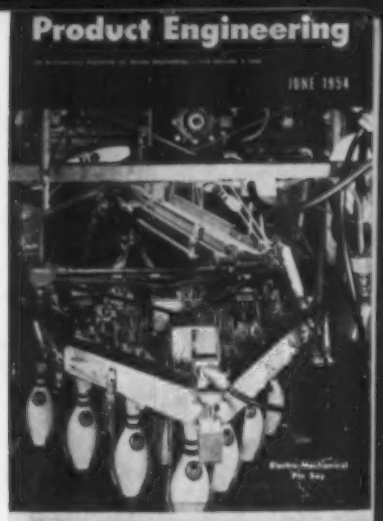

THIS MONTH'S COVER

The AMF Pinspotter, pictured on this month's cover, is the ingenious device designed by American Machine and Foundry Company to automatically set bowling pins and return the ball to the bowler. Almost completely mechanical, the machine relies on simple electrical and electronic circuits to indicate and initiate correct cycling. Complete details, particularly of the mechanical elements, can be found on page 142. Photograph by Sid Karson, McGraw-Hill Studios.

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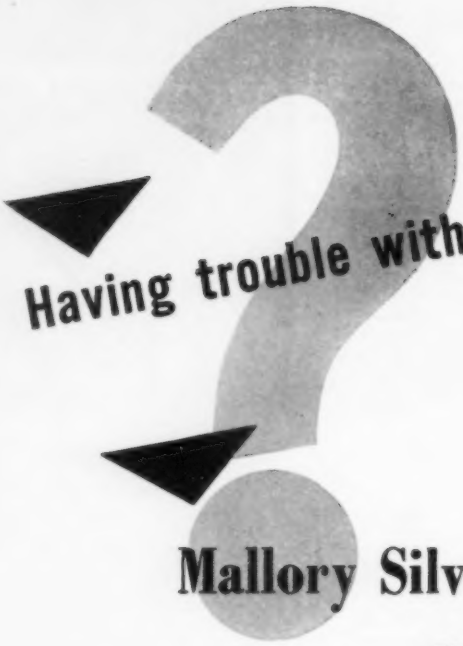

Having trouble with fine-silver contacts sticking?

Mallory Silver-Cadmium Oxide Contacts may solve your problem without increasing costs

If you are having difficulty with fine-silver contacts tending to stick or erode under arcing you may find the answer to better performance in Mallory Silver-Cadmium Oxide Contacts.

Mallory has developed a group of composition materials that have higher conductivity than comparable alloys of the same material and also have a high degree of resistance to sticking and erosion. Here are two typical examples of its performance:

In overload tests on aircraft relays, these Mallory Silver-Cadmium Oxide Contacts interrupted 250% more current without welding than fine silver.

In a 440-volt AC motor controller test, these Mallory Silver-Cadmium Oxide Contacts resisted arc erosion 40% better than fine silver.

Write for your copy of the new Mallory Contact Catalog. It includes a discussion of all Mallory alloys and facilities for producing contacts and contact assemblies for every service.

For an improved combination of high conductivity and anti-sticking qualities, get in touch with Mallory now about silver-cadmium oxide contacts. For applications in the broad field of relays, controllers and motor starters, it is likely they will improve your performance. It is possible they will permit you to re-rate your equipment for higher capacities. And in many cases the cost is no more than for fine silver.

Expect more . . .

Get more from MALLORY

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Electromechanical—Resistors • Switches • Television Tuners • Vibrators
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P. R. MALLORY & CO. Inc.
MALLORY
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Highlights

When requesting further information from companies and organizations mentioned in the items below, confusion can be avoided by referring to the issue of Product Engineering in which items appear. These items represent current research and design developments soon to influence product engineering.

METALLIC MATERIALS

. . . . Thermenol, a high temperature alloy of non-critical metals shows promise as a substitute for certain stainless steels in many applications. Naval Ordnance Laboratory, White Oaks, Maryland, reports the alloy is a modification of 16-Alfenol, a recently announced magnetic material. It is claimed to be 20-25 percent lighter than stainless steel; its physical characteristics include a high tensile strength coupled with a high resistance to corrosion or oxidation.

UPGRADING IRON ORE . . . .

. . . . and iron materials, should ease the present concern over the depletion of high grade iron ore deposits. National Lead Co., 111 Broadway, New York 6, N. Y. and Republic Steel Corp., 1405 Republic Bldg., Cleveland 1, Ohio believe that ferruginous sandstone, containing about 75 percent iron ore, can be upgraded sufficiently to warrant its use in modern blast furnaces. Pilot plant, located near Birmingham, Alabama, is expected to be completed and in operation this summer to test the upgrading technique.

STRIP STEEL . . . .

. . . . electrolytically precoated with an 85 percent lead-15 percent tin alloy, can be soldered without the use of acid fluxes. Thomas Strip Div., Pittsburgh Steel Co., 1646 Delaware Ave., Warren, Ohio, states that the coating is practically free from porosity and has good corrosive resistance. Such a coating—plated out from a fluoborate bath—also acts as a lubricant and reduces wear on dies and forming rolls.

BONDED BORIDES . . . .

. . . . of zirconium, chromium and molybdenum have been developed for high temperature use and for cutting materials. Borolite Corp., 320 Yonkers Ave., Yonkers, New York report that the zirconium carbides have a melting point of 3,000 C, chromium carbides, 1,750 C. Both materials have good high temperature stress rupture characteristics, can be hot pressed, pressure sintered, or cold pressed and sintered.

NEW MG BASE ALLOYS . . . .

. . . . containing additions of titanium, hafnium, rhenium, yttrium and other high melting point elements are the objective of a new research program at Rensselaer Polytechnic Institute, Troy, N. Y. The purpose: to find materials to meet higher requirements in strength at elevated temperatures developed in high speed aircraft. The magnesium development is an attempt to combine a light weight and high temperature alloy for structural parts, such as airframes.

TITANIUM ALLOYS . . . .

. . . . can now be given a tough outer surface comparable, in many ways, to case hardened steel. U. S. Patent No. 2,674,542, assigned to Metal Hydrides, Inc. 12-24 Congress St., Beverly, Mass., states that: powdered tungsten carbide, and nitrides of corresponding metals can be washed over the article in a slurry of molten titanium or zirconium alloys. The parts are heat treated and a hard surface is obtained.

NONMETALLIC MATERIALS

. . . . A plastic sealer for use on equipment with high operating temperatures has been developed by the Presstite Engineering Co., 3798 Chouteau Ave., St. Louis 10, Mo. The material is used, for example, to seal the sides of spot welded seams in furnace casings and is said to maintain permanent plasticity.

GLASS AND PLASTIC . . . .

. . . . may be—in the near future—chemically bonded together to produce airplane bodies, boats and automobiles. Experts of the U. S. Naval Ordnance Laboratory, White Oak, Md., have come up with five new bonding compounds, all belonging to the class known as chlorosilanes. Part of each compound will unite chemically with one of the plastic materials, while another part will join the structure of glass. Tests indicate the finished material combines plastics flexibility with the strength of the glass fibers.

SUCCESSFUL BONDING . . . .

. . . . of Buna N and neoprene rubbers to white metals and aluminum as well as nylon has been developed by the Minnesota Rubber and Gasket Co., 3630 Wooddale Ave., Minneapolis 16, Minn. In developing the metal bonding process, company engineers also discovered the technique for bonding certain rubber compounds to nylon. Nylon bonding is expected to eliminate the need for metal inserts where nylon is used.

(continued on page 7)

Hold your answer! We've got three more questions. Can your part be moulded by thermosetting methods? Can it be moulded with standard thermosetting materials or newer materials like Teflon, Alkyd or glass-reinforced plastics? Do you need quick deliveries in production quantities? Three "yes" answers, and your part problem's solved. We're custom moulders for *any* thermosetting job—with complete moulding facilities, including design and mould making. Phone or write *your* questions to Dayton or your local branch office.

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Kurz-Kasch
FOR OVER 37 YEARS PLANNERS AND MOULDERS IN PLASTICS

Highlights

PRESSURE-SENSITIVE ADHESIVES . . . .

. . . . are being made on a pilot scale by the New Products Engineering Dept., Bakelite Co., Div., Union Carbide and Carbon Corp., 260 Madison Ave., New York 16, N. Y. Adhesives based on the new materials are said to offer stability, lack of color, uniformity and very low toxicity. Polymers are being made in two molecular weights: a relatively low one that is a viscous liquid at room temperature, and a medium high one that is a rubber-like solid with a faint tack.

MYLAR . . . .

. . . . a polyester film, is being tested in many new fields of application. The automobile industry, for example, is experimenting with metal infused Mylar as a substitute for chrome in scuff panels and inside trim. E. I. du Pont de Nemours & Co., Inc., Wilmington 98, Delaware, states the film is unusually resistant to mildew, entirely rust proof and extremely tough. For packaging, the film makes an almost perfect water and vapor barrier, as its moisture absorption is very low—about 0.3 percent after one week of immersion in water. It is also used as insulation in motors, because of its low electrical fault count.

COMPONENTS

. . . . Radioactive material powers a device that measures the thickness of zinc coating on special galvanized steel. Armco Steel Corp., 1939 Armco Ave., Middletown, Ohio, believes the device will help produce better coated steel. This, it is thought, is the first time it has been possible to measure the thickness of a metallic coating as the material is being produced. Armco maintains that the atom powered gage tells—within a few minutes after the steel leaves the zinc pot—how much material has been deposited.

SUNSHINE BATTERY . . . .

. . . . uses razor thin strips of silicon, which, when hit by sunlight, create a flow of electric current at the rate of 50 w per sq yd of surface. Bell Telephone Laboratories, 463 West St., New York 14, N. Y., state that the efficiency of the unit is 6 percent (in contrast with other photoelectric devices which have never been rated better than one percent). The batteries, with further development, should be able to supply power for rural telephone lines. The battery would supply power by day—even cloudy days—and charge up storage units for night operation.

INDUSTRIAL ACID FILTERS . . . .

. . . . made of rigid poly vinyl plastic are lasting 6 times longer than ones of conventional steel, yet cost the same. B. F. Goodrich Co., Chemical Division, 2069 East 9th Street, Cleveland 15, Ohio, report the filters have been used in corrosive nickel plating bath operations for 18 months and show no sign of wear. In contrast: stainless steel filters last only 3 weeks to 3 months before requiring replacement.

AN ELECTRONIC EAR . . . .

. . . . that can detect whether the unnatural noise of, for example, a car is caused by a loose bearing or an unbalanced crankshaft has been perfected by Raytheon Mfg. Co., 90 Willow St., Waltham, Mass. The machine is reported to have a battery of parallel elements that permit it to examine an entire spectrum of sound frequencies at once.

A THERMOMETER . . . .

. . . . that takes the temperature of fuel elements operating nuclear reactors has been developed at the Atomic Energy Commission's Argonne National Laboratory, Bailey & Bluff, Lemont, Illinois. The thermometer is actually a thermocouple made with a copper-nickel-manganese alloy wire inserted in a special type of stainless steel tube. It generates tiny voltages in proportion to the heat it measures. Voltages are read on a sensitive voltmeter and are converted into temperature degrees. Assembly is slightly thicker than a standard hypodermic needle and has measured temperatures to 1,250 Fahrenheit.

BELT DRIVE . . . .

. . . . that gives up to 50 percent greater hp with the same width, or equal hp with ⅓ less sheave width is a development of Raybestos-Manhattan, Inc., 61 Willet St., Passaic, N. J. The belt, which will be called the Poly-V Drive, is claimed to reduce face pressure by one half, thus giving longer life to belt and sheave. It is a single endless rubber belt with a series of parallel V ribs molded lengthwise around the circumference. Most important feature of the drive: it eliminates belt matching problems common to multiple V-belt applications.

PROCESSES

. . . . Titanium separation from its ore by electrolysis is being done on an experimental basis. The process has been worked out by scientists at Columbia University, Department of Engineering, 409 Engineering Bldg., New York 27, N. Y. If proved commercially feasible, process could bring titanium into a competitive price range—especially where titanium's properties warrant its consideration.

(continued on page 9)

Wonder chemical

CHANGES METAL SURFACES, MAKES PAINTED PRODUCTS *look better longer*

NOT ALL "wonder chemicals" are new! Here's one that for more than a score of years has been doing a job that manufacturers at first said couldn't be done.

In as little as sixty seconds, Bonderite changes the surface of metal parts to a *nonmetallic* layer of unusual properties. Bonderite is used on automobile bodies, refrigerator cabinets, transformers, hardware, and metal furniture, to name a few items out of thousands.

This nonmetallic coating does several amazing things. Because it has an affinity for organic coatings and is integral with the metal, it takes and holds paint securely, preventing chipping and peeling. It acts to keep moisture from reaching the metal, thus controlling rust and corrosion. And should the paint film be damaged by accidental scratch or dent, Bonderite prevents the spread of finish failure.

All of these benefits combine to mean lasting fine appearance for those thousands of products whose manufacturers use Bonderite before painting.

Unlike many "wonder chemicals," Bonderite requires no special handling. It produces excellent results in large and small installations, in spray and immersion applications, and on steel, aluminum, zinc, or cadmium and their alloys.

The cost of Bonderite is small—a fraction of a cent per square foot of area treated—and the benefits are great.

Your inquiry will get prompt, expert, helpful attention.

*Bonderite, Bonderlube, Parco, Parco Lubrite — Reg. U.S. Pat. Off.

Parker

RUST PROOF COMPANY

2179 East Milwaukee, Detroit 11, Michigan

BONDERITE	BONDERITE and BONDERLUBE	PARCO COMPOUND	PARCO LUBRITE
corrosion resistant paint base	aids in cold forming of metals	rust resistant	wear resistant for friction surfaces

Highlights

MOLYBDENUM PREPARATION . . . .

. . . . by the electrolytic process has been achieved by scientists at the National Bureau of Standards, Washington 25, D. C. Experiments have produced high-purity molybdenum by electrolysis of a bath of fused salts in a process said to be very flexible and easily controlled. Deposits vary from fine powders to thick, coherent layers. Further developments may make electroforming of molybdenum objects feasible; may also produce cheaper, faster methods for producing molybdenum parts and coatings.

AUTOMATIC PROCESSING EQUIPMENT . . . .

. . . . for handling polyesters, expoxies, and other multicomponent resins on a production line basis has been developed by Applied Engineering Associates, 1952 Flushing Ave., Brooklyn 37, N. Y. The equipment, it is said, automatically performs the functions of deaeration, proportioning of the resin and hardener components, mixing and meter dispensing. Resins in a wide range of viscosity and pot life can be handled. Applications are indicated in the fields of laminating, mat molding, die molding, tooling, sealers, castings, coatings and thermosetting extrusion.

CATHODIC PROTECTION . . . .

. . . . can be given iron or steel to prevent corrosion if the parts are painted with a coating containing a vinyl resin base saturated with high purity zinc powder. Galvicon Inc., 40 West 29th St., New York, N. Y. reports that the coating, when dry, contains 96 percent of zinc by weight. The zinc must be lead-free to afford good protection. Protection is given against dilute acids and vapors, solutions of inorganic salts, humidity, fresh water and salt atmospheres.

METALLIC OBJECTS . . . .

. . . . of cobalt, chromium, nickel, iron or other alloys can be given an aluminum coating by dipping. A Swedish Patent, No. 139,715, describes the process as follows: the surface is first treated by dipping the base metal in a fluid composed of zirconium or titanium fluoride, and then molten Al is applied to the surface.

TESTING

. . . . Tougher plastic dies are expected to alter the production schedule of the automobile industry in the near future. The newest of the plastic dies are being made by The Chrysler Corp., 341 Massachusetts Avenue, Detroit, Michigan. Biggest advantages of the new dies: three to four weeks to make them, contrasted with three to eight months for steel; a cost reduction of 30 percent over steel for short runs and an estimated 70 percent on a large scale basis. Key to the new dies is a secret catalyst that is mixed with a liquid plastic and poured into a plaster mold prepared with strips of glass cloth and a special plastic paste.

HIGH VACUUM . . . .

. . . . can be produced by a simple device—called an ionic pump—that has no moving parts. The pump can create a vacuum as high as one-billionth of normal atmospheric pressure, according to the General Electric Co.'s Research Laboratory, One River Road, Schenectady 1, New York. The pump consists of a circular steel box supported between the poles of a powerful magnet. After most of the air is exhausted, an electric current is introduced. Electrical forces break up, or ionize, the gas atoms and hurl the fragments onto carbon plates where they stick. The gas is thus removed until the desired vacuum is reached.

EXTRUDED ALUMINUM PISTONS . . . .

. . . . that are said to be 50 percent stronger and 30 percent lighter than conventional cast aluminum pistons are now undergoing field tests. Thompson Products Co., 23555 Euclid Ave., Cleveland, Ohio, reports that the pistons are formed by impact extrusion under heat from cast aluminum slugs cut from bar stock. Laboratory tests at Thompson have shown no fatiguing at 40 million cycles with a simulated engine compression ratio of 13.8 to 1. Similar pistons, made by the conventional casting process, showed fatiguing at 10 million cycles.

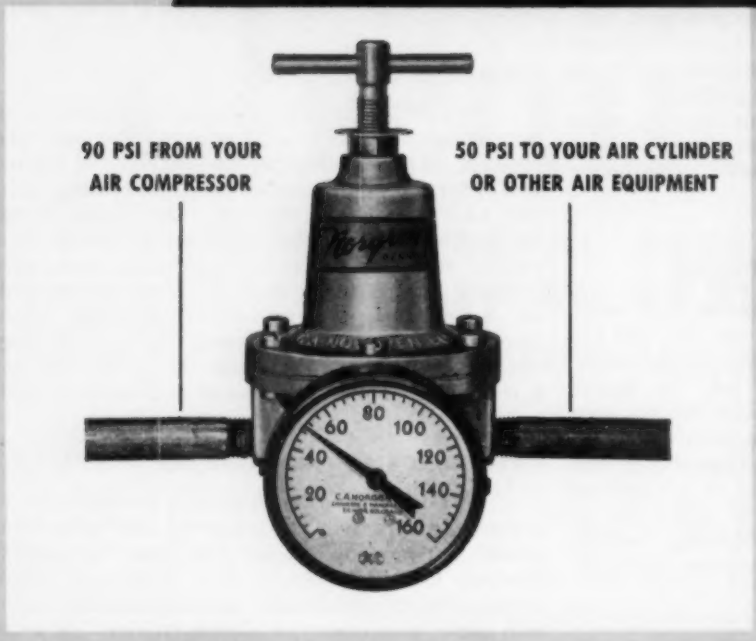
AN OZONOMETER . . . .

. . . . is being used to measure the ozone concentration in the air in an attempt to find ways of preventing ozone cracking in rubber products. Experts at B. F. Goodrich Co., Research Center, Brecksville, Ohio, have been taking daily measurements of ozone concentration, which has been found to vary daily. The primary objective: to find a compounding ingredient that will act as a counter-agent for ozone. The new instrument promises to be a powerful tool in this research project to counteract cracking.

A RESILIENT MOUNTING . . . .

. . . . project for the development, investigation, and evaluation of mountings for shock, noise and vibration isolation is underway at the Research and Development Div., Bureau of Ships, Washington 25, D. C. So far, two sizes of a low frequency resilient mounting have been tested. These mountings are expected to reduce the structure-borne noise aboard Navy vessels. The two new mountings are further expected to reduce cost and inventory, since they cover a range that previously required eight different sizes.

Why waste compressed air at 90 psi where 50 psi will do a better job ?...



...and

- *reduce wear on air equipment*
- *save dollars on air costs*

USE NORGREN PRESSURE REGULATORS

Norgren Regulators more than pay for themselves in savings in air costs alone. More important—they accurately control air pressures to assure proper operation of equipment and minimum maintenance costs. Available in wide range of remote control, low pressure, relieving and cylinder gas types.

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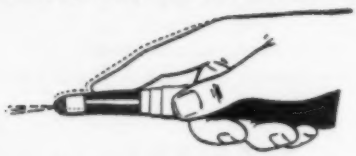
PIONEER AND LEADER IN OIL-FOG LUBRICATION FOR 26 YEARS

ANOTHER IDEA FOR CUTTING AIR COSTS



A blow gun with 90 psi line pressure uses 10½ cfm of air. 30 psi usually does the job just as well and uses only 4½ cfm . . . saving 6 cfm every minute—on one gun used an average of one hour per day the saving would be 90,000 cu. ft. of air per year.

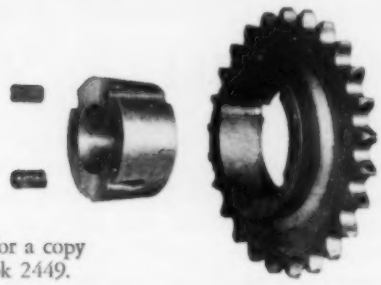
VALVES • FILTERS • REGULATORS • LUBRICATORS • HOSE ASSEMBLIES

SAVE TIME! SAVE MONEY!

Use Link-Belt roller chain sprockets with taper lock bushings

Faster, less expensive procurement!

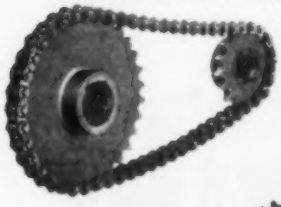
There's no delay for reboring when you need sprockets in a hurry. You can pick these *right off the shelf*. Stocks include sizes for single width chains from RC-40 through RC-160.



Send for a copy of Book 2449.

Faster, less expensive installation and removal!

No need to fit sprocket to shaft. Setscrews draw sprocket onto taper bushing, causing bushing to clamp tightly on shaft — equivalent to shrink fit. Turning setscrews in removal-holes quickly releases sprocket from shaft. Full bushing length supports sprocket on shaft.



AN IDEAL COMBINATION: Link-Belt Precision Steel Roller Chain and Link-Belt Sprockets

LINK-BELT

ROLLER CHAIN AND SPROCKETS

LINK-BELT COMPANY: Executive Offices, 307 N. Michigan Ave., Chicago 1. To Serve Industry There Are Link-Belt Plants, Sales Offices, Stock Carrying Factory Branch Stores and Distributors in All Principal Cities. Export Office, New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville, N.S.W.; South Africa, Springs. Representatives Throughout the World.

13.507

for **LIONEL**

Here's Why .....

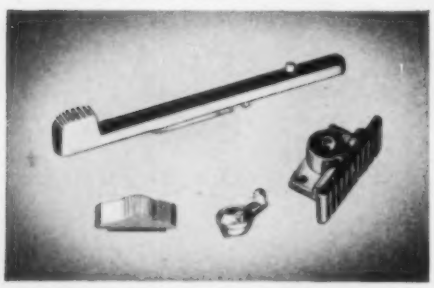
Drawing on the engineering know-how accumulated in the long-time manufacture of model electric train equipment, the Lionel Corporation has been highly selective in the materials and processes for the production of the new **LINEX** Stereo Camera*. It is of particular significance, therefore, that **ZINC** Die Castings are used for the complete camera case and front cover plate (above) as well as for the four operating components shown below.

*The LINEX is a brand new product just introduced in New York City by the Linex Corporation—a Division of the Lionel Corporation. It takes full color 3-dimensional pictures and is sold, complete with shoulder strap, carrying case, viewer and film for $44.50. It should soon be available throughout the country.

Low Cost—Die casting is the only method by which these parts could be produced at reasonable cost and ZINC provides the utmost in castability. The complexity of shape thus achieved not only permits an unusually compact assembly but greatly minimizes the need for costly machining and assembling operations.

Top Quality—Obviously a high degree of dimensional accuracy is required for this type of application and ZINC rates highest among the commonly used die casting alloys in this respect. ZINC Die Castings also assure *toughness* to withstand abuse and they provide sufficient weight to give the camera a "feel of quality." The as-cast surfaces of the large castings are easily finished in an attractive wrinkle-enamel and the small parts are electroplated.

Ask us—or any die casting company—for a copy of "The End Uses of Zinc Die Castings" to learn about the diversity of ZINC Die Casting applications.



The New Jersey Zinc Company
160 Front St., New York 38, N.Y.

ZINC
FOR DIE CASTING ALLOYS

The Research was done, the Alloys were developed, and most Die Castings are based on
HORSE HEAD SPECIAL (99.99+% Uniform Quality) ZINC

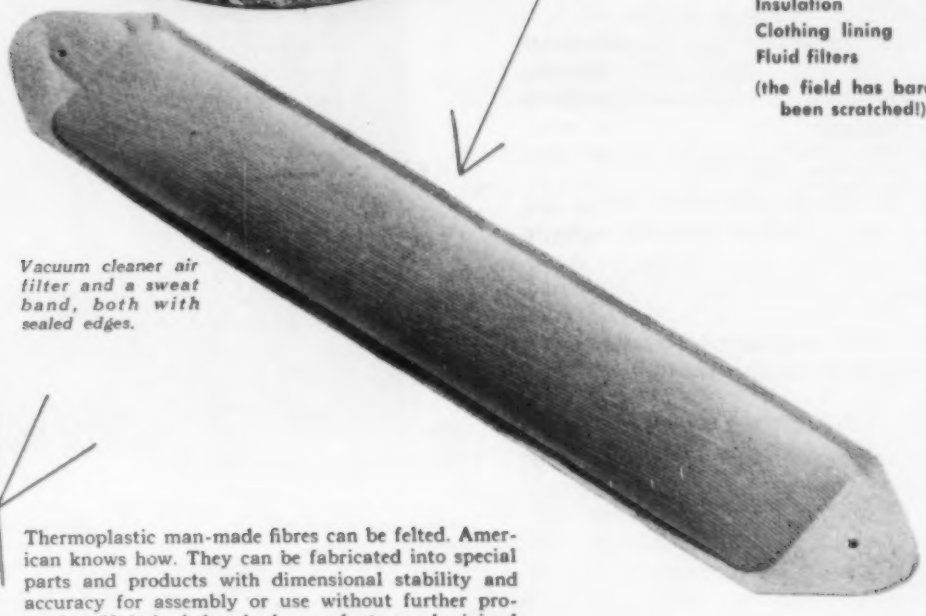
SCIENCE MAKES POSSIBLE

FUSED EDGES

U. S. Pats: 2521964 2521965

Some Present Uses

Dust shields
Vacuum cleaner filters
Powdered soap containers
Face powder pads
Insulation
Clothing lining
Fluid filters
(the field has barely been scratched!)



Vacuum cleaner air filter and a sweat band, both with sealed edges.

Thermoplastic man-made fibres can be felted. American knows how. They can be fabricated into special parts and products with dimensional stability and accuracy for assembly or use without further processing. If desired, fused edge products can be joined to other fabrics instead of by the conventional methods of stitching, adhesives or clamping. The felt within the edges can have any desired porosity, or density characteristics, within wide limits, since such felts can be made entirely of manufactured fibres, or contain mixtures of natural and man-made fibres. Thus these fused-edge felts have great versatility, and are capable of rendering many different services. It will pay you to look into what fused-edge felt products and parts can do for you. Write for information on your company letterhead.

American Felt Company

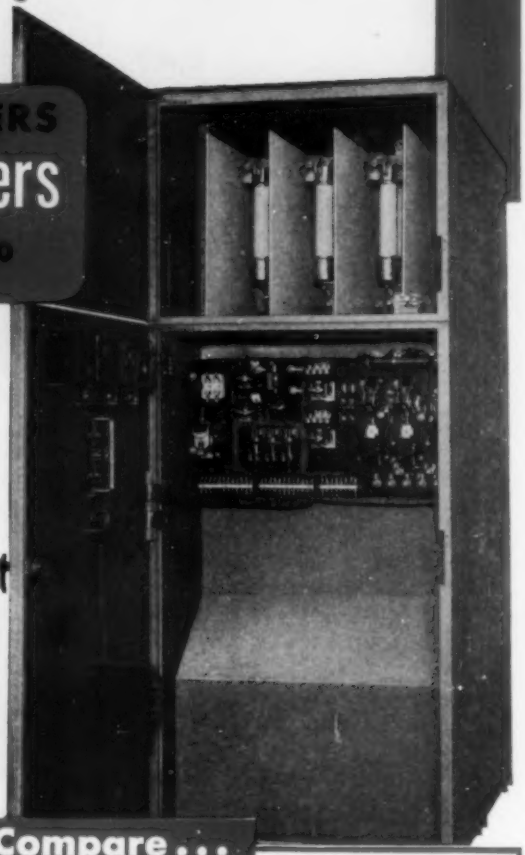
TRADE MARK

78 GLENVILLE RD. GLENVILLE, CONN.

Current Limiting Fuses Clear Short Circuits in Less than ½ Cycle

ALLIS-CHALMERS Type H Starters

FOR 2300 TO 5000 VOLT MOTORS



With Allis-Chalmers Type H Starters, your motors, cables and associated equipment are protected against short circuits by fast-acting current limiting fuses. These fuses cut off short circuit current at a *low safe peak value*. The short is cleared in less than a half cycle . . . thus minimizing the possibility of damage.

Noiseless, Safe, Positive

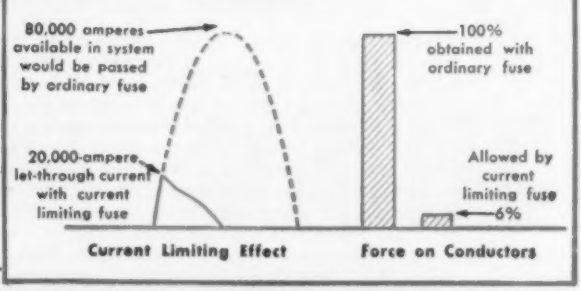
Action is silent. An indicator in the end of fuse reveals occurrence of short. Blown fuse emits no gas, flame nor vapor . . . discharges no metal. Flashover caused by ionized vapor is eliminated. Fuses will not blow unnecessarily . . . protection against locked-rotor or single-phase conditions is provided by overload relays coordinated with fuses.

The FULL Protection Starter

Quick action short circuit protection is a part of the *Full Protection* engineered into a Type H starter . . . complete, positive protection which permits men to work in safety, guards motors and machines against costly damage, lengthens equipment life, increases production by reducing down time. Get all the facts from your nearby A-C representative or write Allis-Chalmers, Milwaukee 1, Wisconsin.

A-4368

Compare . . .


80,000 amperes available in system would be passed by ordinary fuse
20,000-ampere let-through current with current limiting fuse
100% obtained with ordinary fuse
Allowed by current limiting fuse
6%
Current Limiting Effect
Force on Conductors

A-C ALLIS-CHALMERS

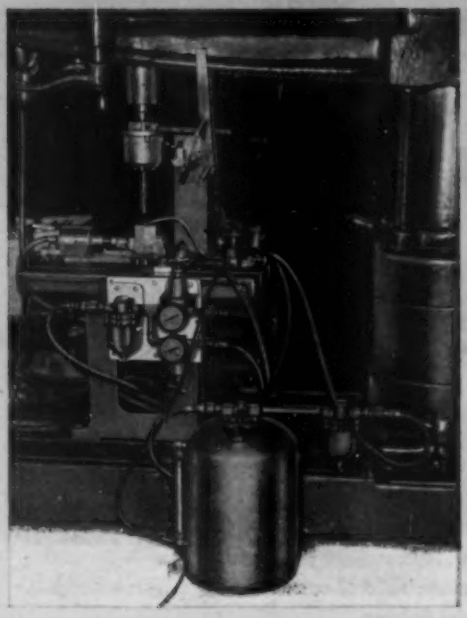
ALLIS-CHALMERS

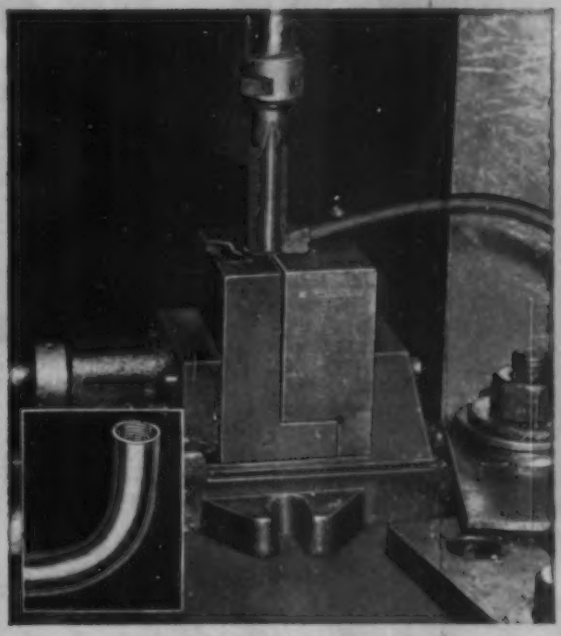
NEW *Norgren* **Spray-Lube** *System*

applies special compound for tapping 100% thread in thin-wall aluminum tubing

increases output 35%
improves quality
eliminates hand operation

at
STANDARD TOOL & MACHINE CO.
St. Louis





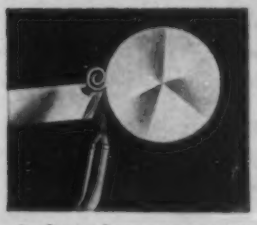
Norgren Spray-Lube System gives more efficient application of cutting oils for:

- *higher cutting speeds*
- *faster rate of feed*
- *longer tool life*
- *lower unit production costs*

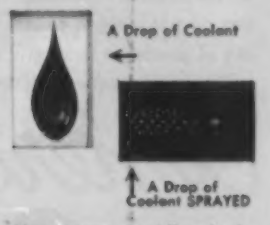
on tapping machines, drill presses, milling machines, grinders, lathes, boring machines, high-speed saws, stamping presses, deep draw presses.

WRITE FOR COMPLETE DATA
NEW FOLDER No. 491

C. A. *Norgren* CO.
3428 So. Elati, Englewood, Colo.



Coolant where you need it ... spray is applied to work area from any required direction to thoroughly lubricate critical contact areas between cutting tool and work piece.



Fine spray rapidly dissipates heat... the spray lubricates tool more efficiently; has greater exposed oil surface area for fast, thorough dissipation of heat.

PIONEER AND LEADER IN OIL-FOG LUBRICATION FOR 26 YEARS

VALVES FILTERS HOSE ASSEMBLIES REGULATORS LUBRICATORS

Rugged packaging

–helps make

USS Amerstrip

America's preferred strip steel

Every shipment of USS Amerstrip gets to you quickly, and *intact*. Amerstrip is tightly bound to a sturdy wooden pallet with steel bands. It travels the roughest roads, the fastest freights, without damage. Assurance that Amerstrip will arrive in good condition, ready to use, is one reason why it is more widely used in a greater variety of products than any other strip steel.

Amerstrip comes in a complete range of analyses and tempers in carbon, stainless, and alloy steels . . . in coils or cut lengths . . . with a round or square, natural or rolled edge . . . in *all* commercial finishes.

If you have any question about the selection or use of strip steel, write to American Steel & Wire, Room 842, Rockefeller Building, Cleveland 13, Ohio. Our steel specialists will be glad to help you.

Amerstrip

CARBON • ALLOY USS STAINLESS

AMERICAN STEEL & WIRE DIVISION
UNITED STATES STEEL CORPORATION
GENERAL OFFICES: CLEVELAND, OHIO
COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO
TENNESSEE COAL & IRON DIVISION, FAIRFIELD, ALA., SOUTHERN DISTRIBUTORS
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

UNITED STATES STEEL

New!

VARY-TALLY

Multiple-Unit Reset Counter

DESIGNED TO COUNT ANYTHING COUNTABLE

this new Vary-Tally can be supplied in any combination up to 6 banks high, 12 units wide, with the counting units arranged compactly on stands in tiers. Now check these special features of Veeder-Root design and construction:

- Easily Readable from any Angle . . . Bold Figures Always Centered in Window . . . No Glare . . . Figures not Covered by Fingers in Operation
- Easily Portable, yet Ruggedly Built for Long Wear
- Separate Counting Units Can be Rotated like Tires on a Car, to Distribute Wear Evenly
- All Parts Corrosion-Resistant
- Working Parts of Hardened Steel
- Operation Not Affected by Extreme Heat or Cold
- Individual Tag Above Each Counter-Window — Not Strip Tabs
- Veeder-Root Quality in Every Part

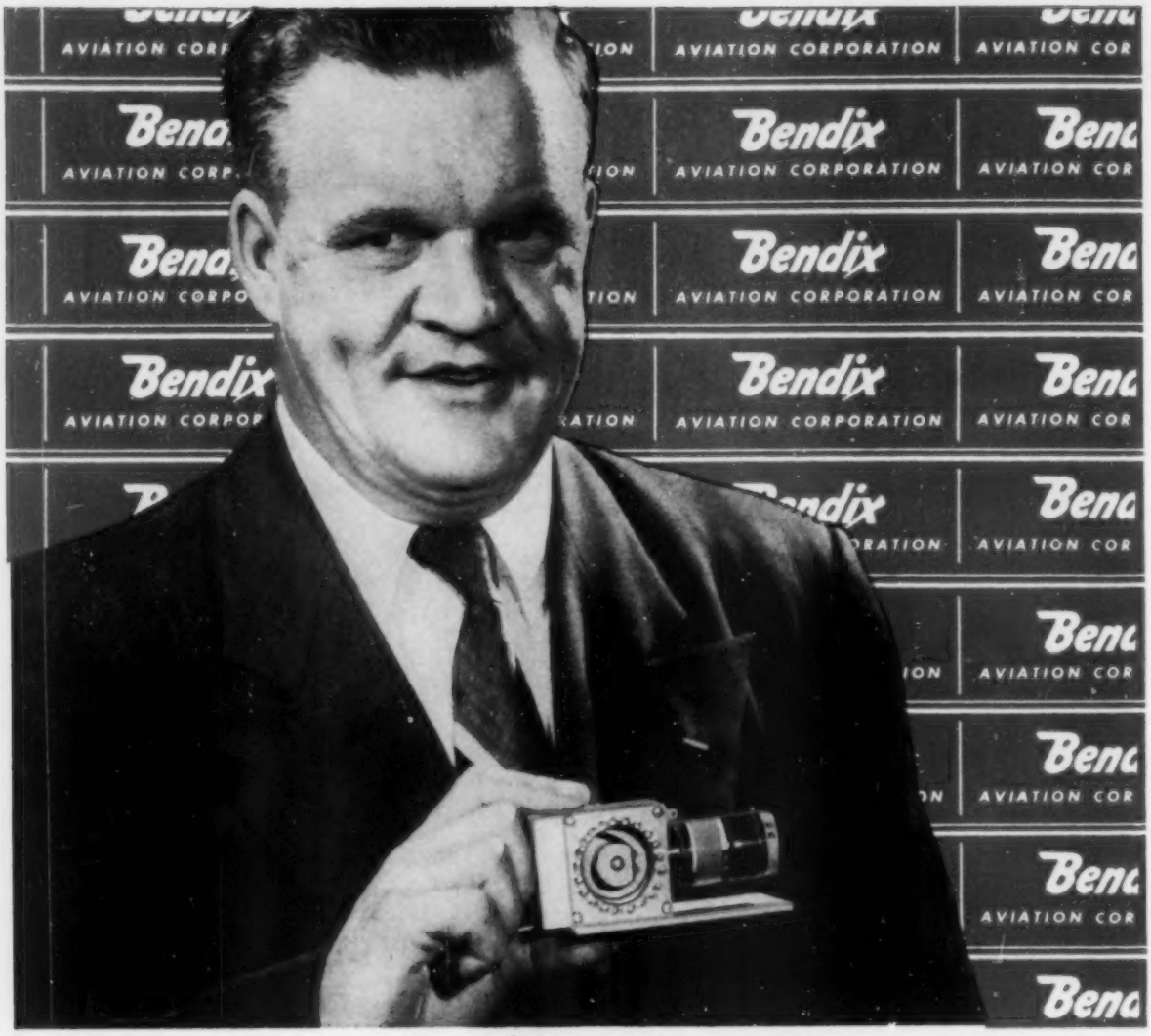
Now what's on *your* mind, that Vary-Tally can help you count? Write for news sheet and prices.

"The Name that Counts"

VEEDER-ROOT INC.

HARTFORD 2, CONNECTICUT

Chicago 6, Ill. • New York 19, N. Y. • Greenville, S. C. • Montreal 2, Canada • Dundee, Scotland • Offices and Agents in Principal Cities



P. Roy Marshall of the Bendix Aviation Corporation says:

"We save more than the cost of a mold on every run... thanks to Plaskon® Alkyd"

"As compared to the expense of fabricating commutators and other complex parts from sheet stock, we save many times the cost of the mold on every run by using PLASKON Alkyd reinforced with glass fibers."

So successful has been Bendix aviation experience with Alkyd, that they are using it for 24 critical parts in which lack of strength and dimensional stability would be disastrous.

And other electronic manufacturers, with increasing frequency, are turning to PLASKON Reinforced Alkyd for molding intricate parts that previously had to be made by costly, multiple-assembly operations.

They are discovering that PLASKON Alkyds save them time and money, and that, because of the superior strength and electrical qualities of Alkyd, better products can be made.

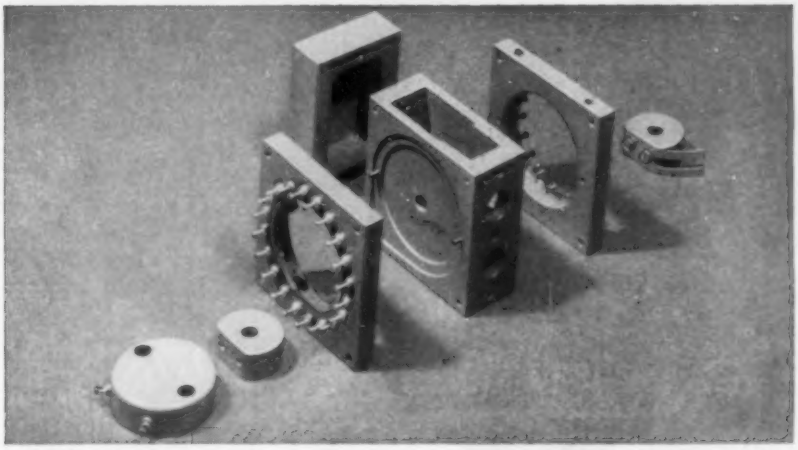
Other PLASKON Alkyds include granular and putty type compounds. Like Reinforced Alkyds, these have the excellent electrical properties, dimensional stability and molding characteristics that help solve many production headaches in jobs for which they are specified.

Why not find out what PLASKON products can do for you? Our technical staff is ready at all times to discuss your problems, help you find the right material for your needs. Write today or call your nearest PLASKON Man. He'll be glad to assist you without obligation.

9 advantages for the electronics industry

with PLASKON® reinforced ALKYD

1. **Elimination of costly fabrication reduces production costs**
2. **Provides solid mounting for inserts**
3. **High dielectric strength**
4. **Superior arc resistance**
5. **Extreme dimensional stability**
6. **Great impact strength and shock resistance**
7. **Resistance to heat and fire**
8. **Can be molded to extremely close tolerances**
9. **Outstanding structural strength**



Dimensional stability of Plaskon Reinforced Alkyd allows close-tolerance molding of this disassembled commutator body. Excellent bonding with metal saves cost on expensive silver inserts. Strength of material allows molding of thin sections. Most important, PLASKON Reinforced Alkyd saves money by cutting down rejects. Pieces shown are molded by Bridges Plastic Products, Inc. (Los Angeles).

For further information on PLASKON plastics and resins address BARRETT DIVISION, Allied Chemical & Dye Corporation, 40 Rector Street, New York 6, New York. WHitehall 4-0800.

Why stop AUTOMATION at Assembly?

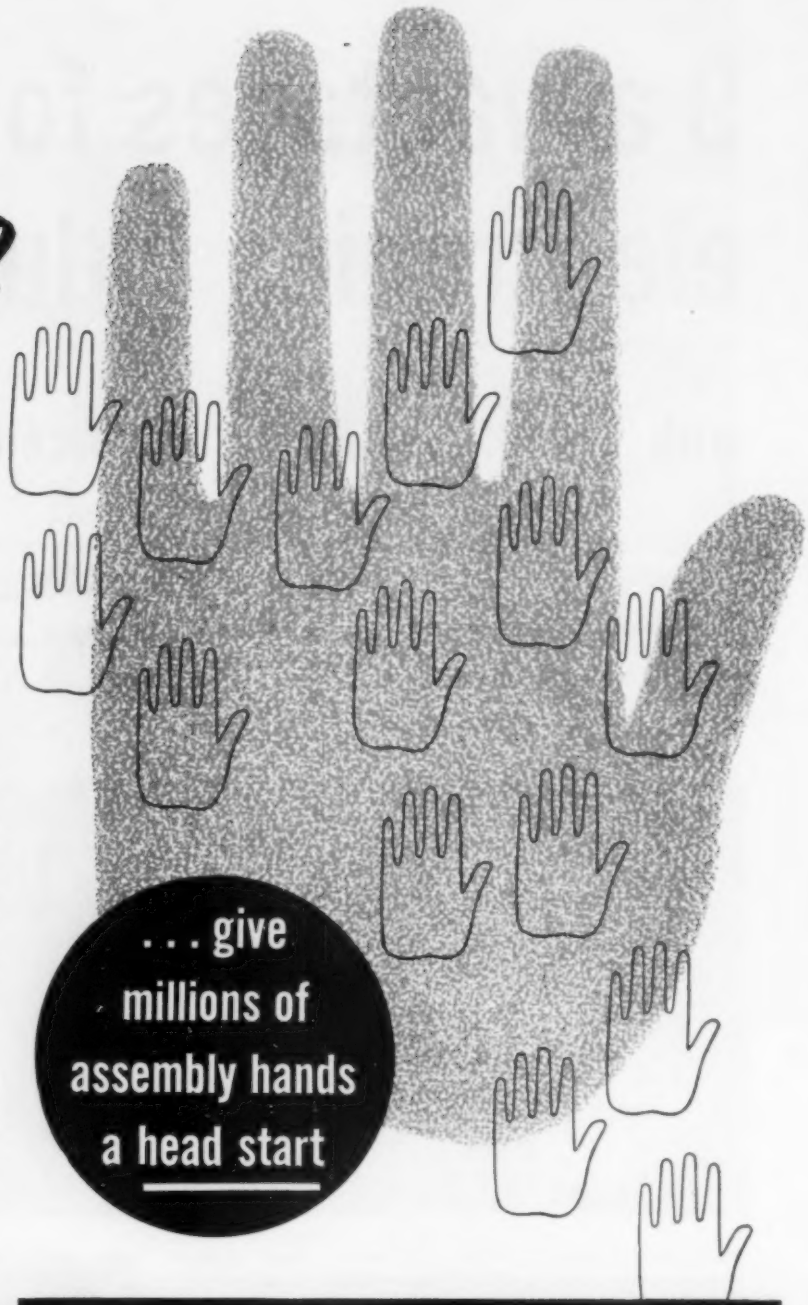
Automation is a new name for an objective long pursued by industry's keenest minds. It means successive elimination of manual operations.

In the production of metal or plastic component parts — by machining, molding, etc. — automation has made advances that in some cases seem almost magical.

By contrast, *assembly* often plods along slowed by outdated methods.

Progress toward automation *does not* end where assembly begins for manufacturers who take full advantage of the P-K Fastening Method. They *eliminate* manual operations like tapping, nut-running, inserts in plastic — and avoid the attendant trouble and expense. Automatic screw driving equipment can be used to further mechanize hand operations on many applications. Savings run up to 50% and more.

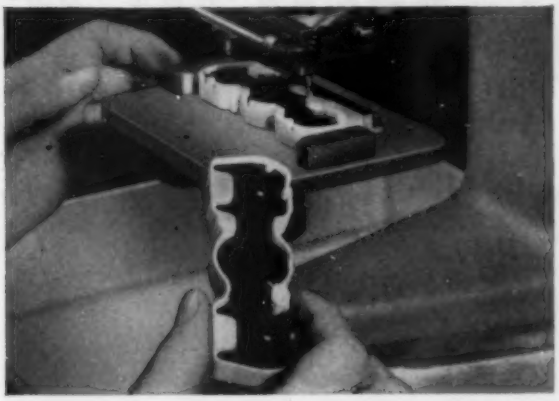
Complete automation is, for most, a *distant* dream. Meanwhile, assembly *hands* control your fastening costs. Find out how P-K Self-tapping Screws can *double — even triple* — their efficiency. It *pays* — and pays well — *today*. Talk to a P-K Assembly Engineer. Parker-Kalon Division, General American Transportation Corporation, 200 Varick St., New York 14.



PARKER-KALON®

IN STOCK . . . see your nearby P-K Distributor . . .

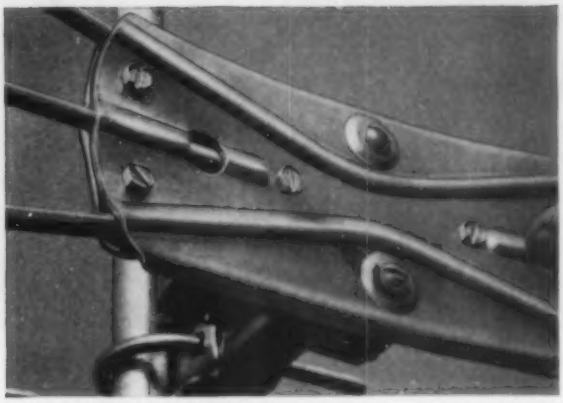
AUTOMATIC DRIVING adds *extra* speed to the faster P-K Fastening Method. Here, an automatic, double-spindle, hopper-fed machine is being used for driving two P-K Type U Drive Screws simultaneously in a plastic electric outlet. Single or multiple spindle machines are available from several manufacturers.



MAYTAG ASSEMBLY MOVES FASTER because fastenings made with P-K Self-tapping Screws are simpler, easier, dependably secure. In the Maytag Dryer shown, 80 Type A and 46 Hex Head Type Z are used, in all, for fastening sheets from 24 to 11 gage — driven with air-operated tools.

with P-K quality–planned assembly savings pay off

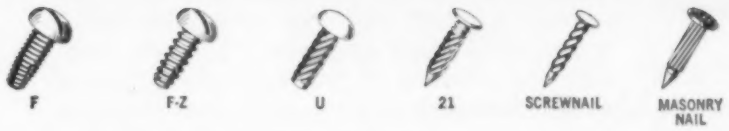
EVINRUDE RELIES ON PROVED STRENGTH of P-K Self-tapping Screws for this critical fastening in an outboard motor sub-assembly, where lasting security is vital. A P-K Binding Head Type F is driven through a die-cast aluminum drive housing and acts as a retainer for the stamped aluminum exhaust baffle.



TELEREX GETS CLEAR PICTURE of performance. For this "Hi-V" Reflector, Telerex, Inc., needed proved resistance to high tension and vibration. They specified 17 slotted Hex Head Z, reasoning soundly that P-K, the *originator*, knows best how to put uniform hardness and toughness in *every* screw.

The Original

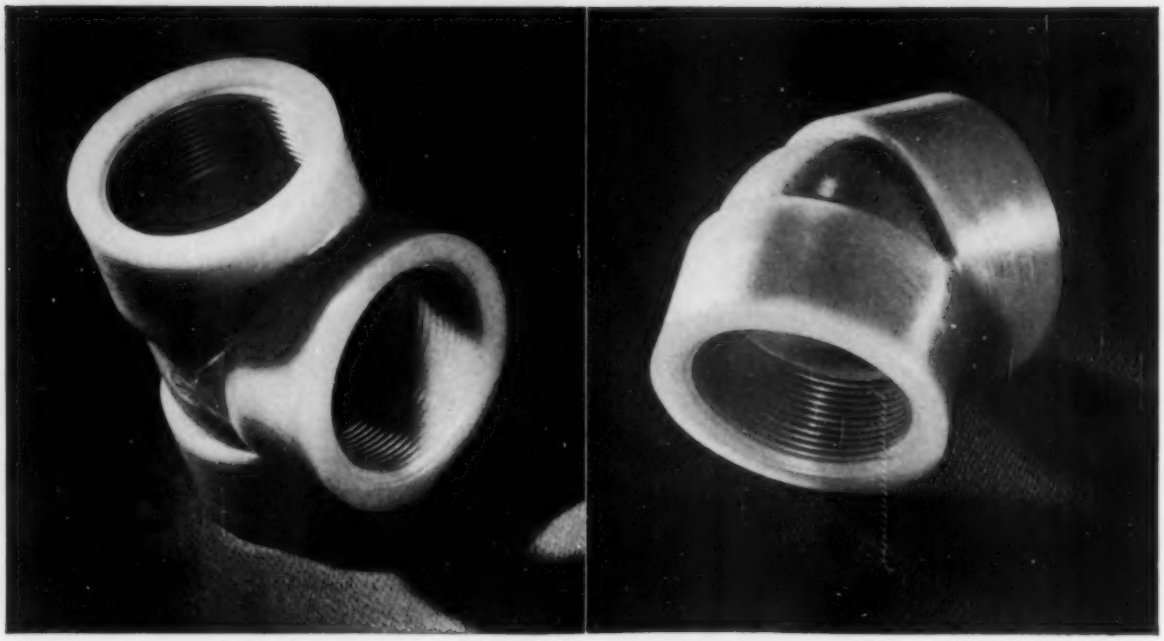
SELF-TAPPING SCREWS



your local Supply and Service Specialist

NOW! THE NEW MATERIAL

INJECTION MOLDED



PROCESSED FROM Firestone's

THE development of *injection molded* Unplasticized P.V.C., made from Exon 402-A is another indication of the wide versatility of this new material of construction. This achievement makes possible the manufacture of corrosion-resistant construction materials of countless sizes and shapes—produced quickly, with high strength and at low cost.

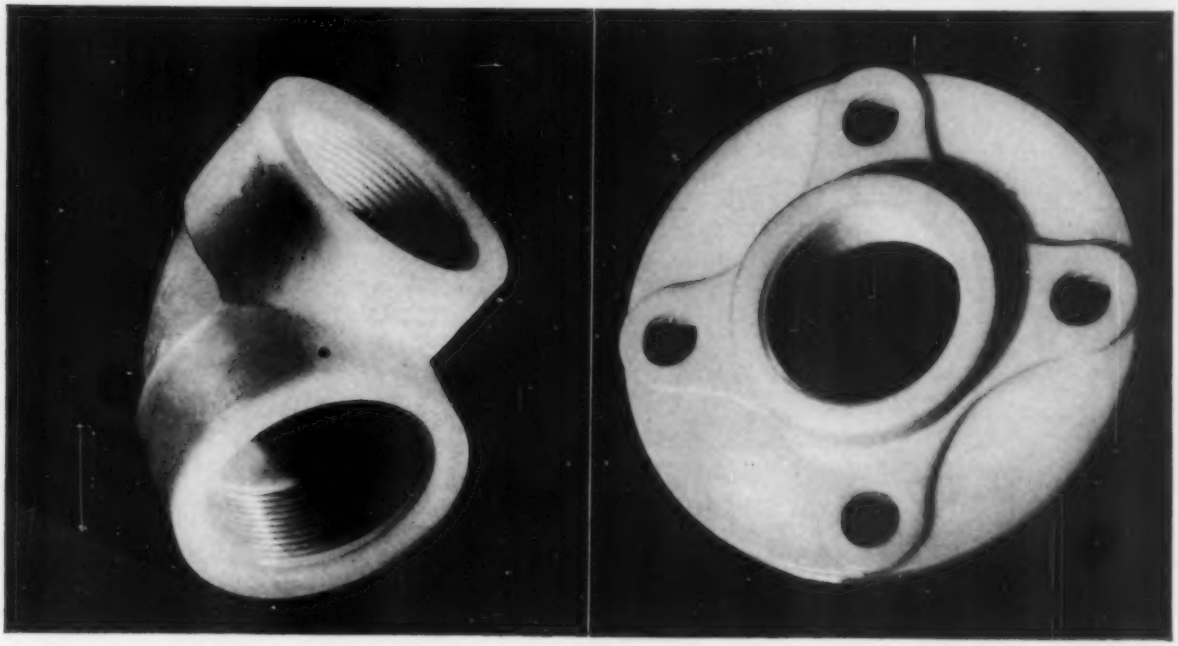
Now rigid pipe fittings of Standard I.P.S. sizes ½" through 4", slip-fit and threaded, are being produced on a Jackson & Church press utilizing the Hendry pre-plasticizing process.

Using Firestone Exon 402-A as the basic material, Jackson & Church, Saginaw, Mich., are turning out completely uniform, strain-free products with excellent chemical resistance and inertness.

Whenever your Unplasticized P.V.C. applications call for injection molding, Exon 402-A can provide the qualities of toughness and corrosion-resistance to the final product. Consider what this new material of construction in injection molded form can do for you. Contact Firestone today for complete details about Exon 402-A—its uses, methods and advantages.

OF CONSTRUCTION...

UNPLASTICIZED P.V.C.



EXON 402-A

SPACE 341

national plastics exposition
CLEVELAND
JUNE 7-10
1954

EXON

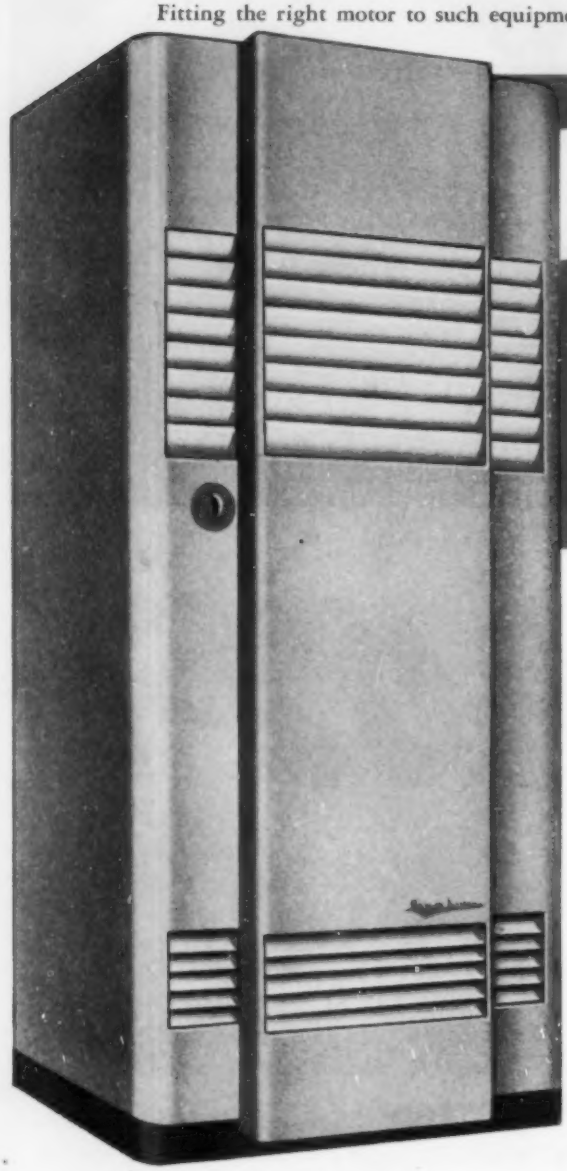
For complete information on the entire line of Firestone **EXON** *Resins,*
call or write: **CHEMICAL SALES DIVISION**
Firestone Plastics Company, Pottstown, Pa., Dept. 6B, Division of The Firestone Tire & Rubber Co.

Wagner®
ELECTRIC MOTORS
... the choice of leaders in industry

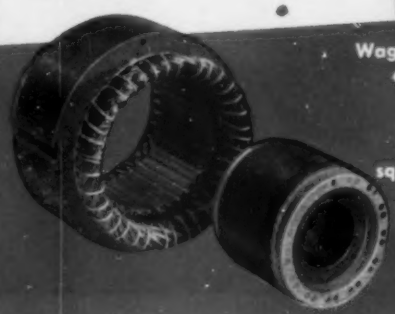
You can depend on *plenty of power*

Motors that drive compressors, pumps and blowers need plenty of electrical and mechanical stamina to hold up under the hard steady grind demanded by these applications.

Fitting the right motor to such equipment is not a problem of designing and building special motors, but of choosing a standard Wagner Motor suited to the job. Wagner Motors are diversified in design and can be readily adapted to a wide range of such applications.



COMPRESSORS



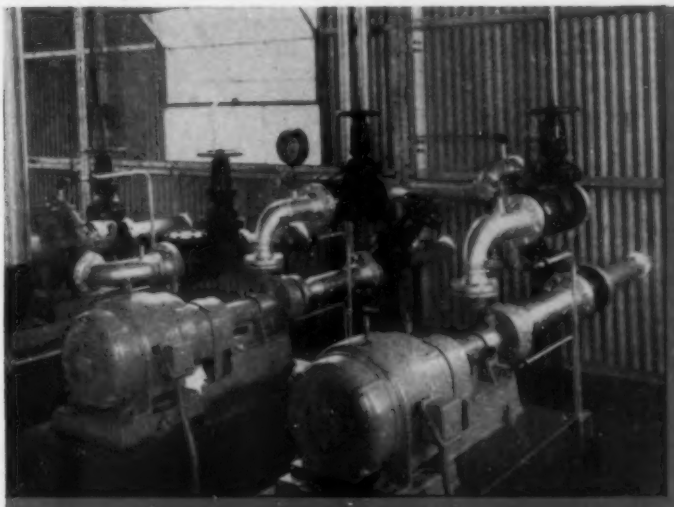
Wagner Hermetic Motor of the type used in self-contained air conditioners. This 7½ hp polyphase squirrel-cage motor is especially designed for sealed units.

Improve the performance economy and dependability of your product by choosing Wagner Motors as standard equipment.

When you standardize with Wagner—you get the advantages of a liberal warranty and of nationwide service facilities, with on-the-spot service, replacement motors and parts available from 25 Wagner-owned Service Branches and more than 750 Authorized Service Stations. You can choose from a wide variety of types and sizes (from 1/125 to 400 hp).

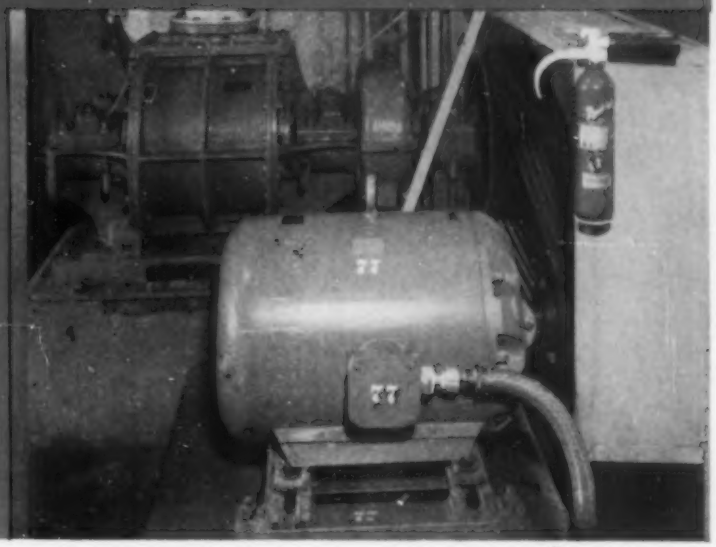
Bulletin MU-185 gives information on the complete line. Let a skilled Wagner engineer discuss your motor needs with you. Just call the nearest of our 32 branch offices, or write us.

Wagner Motors to furnish for your product



Wagner 15 hp Splash-proof polyphase motors driving water circulating pumps at a large oil processing plant in Louisiana.

Wagner 40 hp Explosion-proof motor driving a blower to draw grain into a hopper at a Southern brewery.



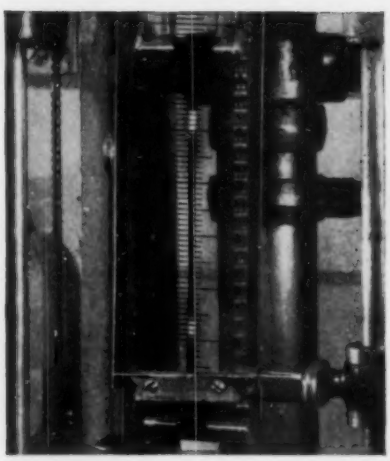
Wagner Electric Corporation
EST. 1891

WAGNER ELECTRIC CORPORATION
6406 Plymouth Ave. • St. Louis 14, Mo., U. S. A.

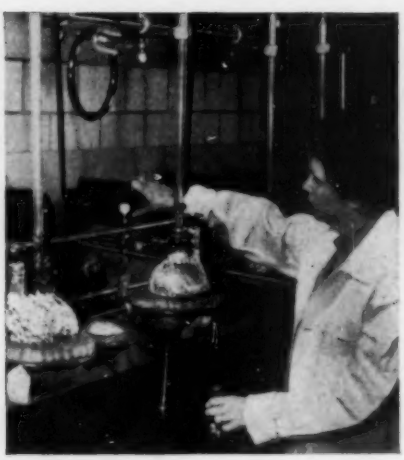
ELECTRIC MOTORS • TRANSFORMERS • INDUSTRIAL BRAKES
AUTOMOTIVE BRAKE SYSTEMS — AIR AND HYDRAULIC

BRANCHES IN 32 PRINCIPAL CITIES

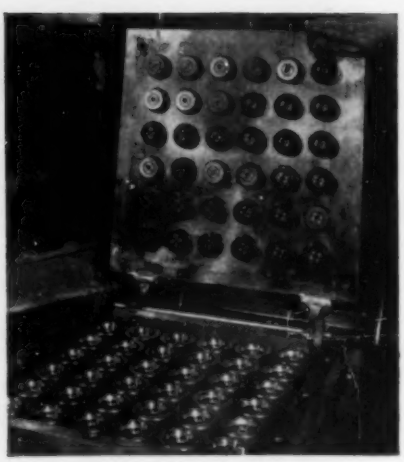
No wonder



2. Elongation, tensile strength and maximum compression set ratings are determined with care. Laboratory and service tests make sure these rated characteristics are held.



3. Fluid and temperature tests check compound resistance to oils, fuels and chemicals at high and low temperatures . . . assuring the long life of Parker O-rings.



4. Precision molding of superior compounds provides close tolerance fits. Parker has molds for *every* standard O-ring size. Mail coupon for data.

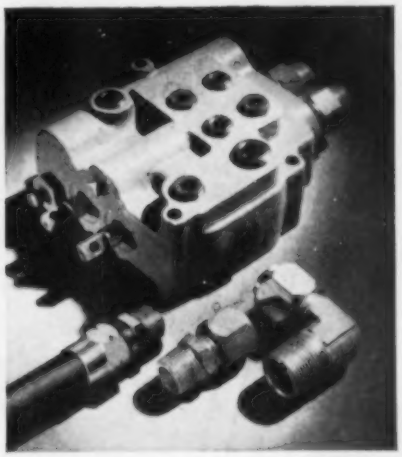
the other one leaked!

Comparison tests prove Parker-formulated rubber O-rings successfully withstand fluid, temperature, pressure conditions

1. New non-flammable hydraulic fluids ruined one O-ring . . . didn't harm the other in this sealing test. Both were originally the same size. Yet, one is now swollen, chewed and chipped. The other wasn't damaged because it was molded of a Parker compound that resists nonflammable fluids.

Pressure and temperature can also cause problems. When you use Parker O-rings, you are sure to get exactly the *right* O-ring for your *specific* application. We invite you to compare Parker O-rings with any other make. Here are some of the reasons why you'll find they seal better and last longer . . .

5. Compare actual samples. Ask your Parker representative to check your specifications. Prove how Parker O-rings seal better and last longer.



6. What other Parker products interest you? *Triple-lok* flare tube fittings, *Ferulok* flareless tube fittings? *Haze-lok* fittings and hose assemblies? Directional control valves?

RUBBER PRODUCTS DIV.
THE PARKER APPLIANCE COMPANY
Section 507-L
17325 Euclid Avenue
Cleveland 12, Ohio

Please send me the following information:

☐ O-ring catalog No. 5100

☐ Custom-molded rubber catalog No. 5201A1

NAME_____ TITLE_____

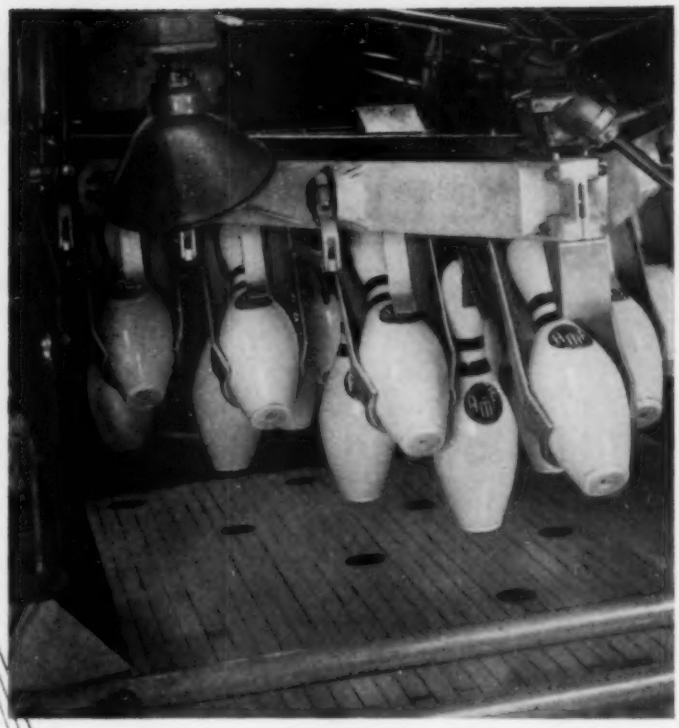
COMPANY_____

ADDRESS_____

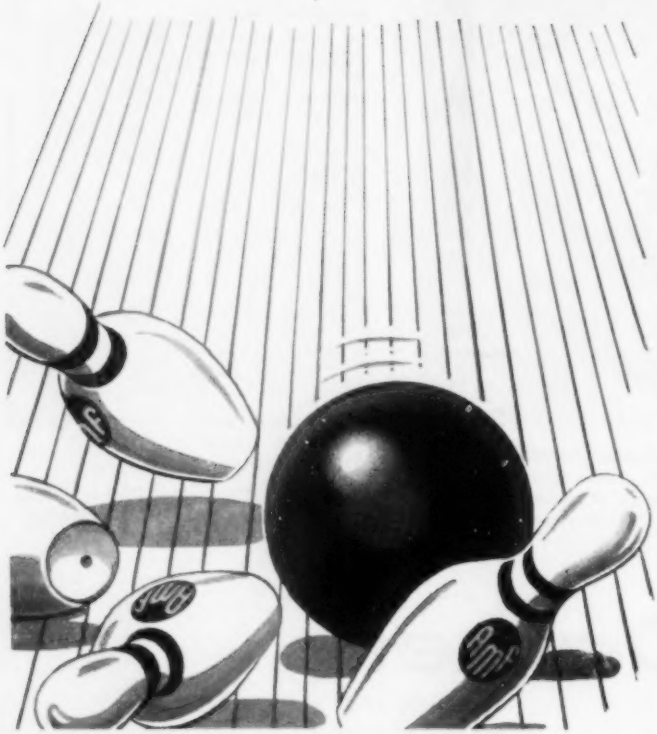
CITY_____ STATE_____

RUBBER PRODUCTS DIVISION
The Parker Appliance Company
17325 Euclid Ave., Cleveland 12, Ohio
1538 South Eastern Ave., Los Angeles, Cal.

Parker
Hydraulic and fluid system components



How Doehler-Jarvis is helping AMF



story of AMF's unique Automatic Pinspotter and the 99 Doehler-Jarvis die castings that make it economically practical.

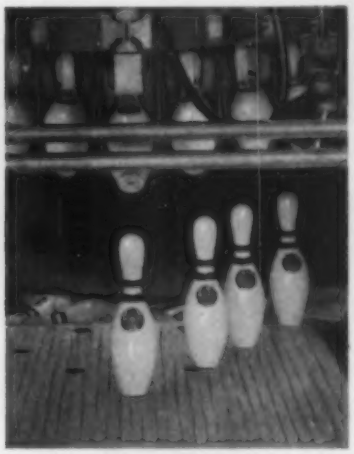
Crac . . . ck! Your pins fly . . . all but four!

Woosh! The pinspotter goes into action, the instant your ball hits the pit . . . to lift the four standing pins, sweep deadwood into the pit, return the ball to you, and re-set the four standees *exactly* where your first ball left them.

Crac . . . ck! Your second ball hits to give you your 10th frame spare, extra ball, and then the game. As the pinspotter spots a new set of pins, you take time out for refreshment . . . and a look behind the scenes at the marvelous machine that automates bowling.

This unique pinspotter practically thinks for itself, adjusts to all the variables of the game and bowler. It is simple, as fast as the bowler, precise, and unbelievably reliable.

"Pinwheel" lifts pins from pit to distributor which delivers them into die cast spotting cups (left). Other Doehler-Jarvis castings are used to guide rods that clamp pins to "pinwheel" and to mount distributor head (above).



Standing pins moved off spot by first ball, must be held above pin deck for return to same position for second ball while deadwood is swept away. How the pinspotter accomplishes this is shown below.

Sponge rubber pad, supported in a Doehler-Jarvis die casting, locates the "off-spot" pin, grasps it, lifts it, and puts it down exactly where it was before, thus conforming with one of the game's most rigid rules.

automate bowling...

It could be prohibitively expensive . . . A production man's nightmare.

But American Machine & Foundry Company found ways to keep costs down. Right at the start they brought Doehler-Jarvis into the picture.

Together, engineers from both companies went over the prototype piece-by-piece, operation-by-operation . . . looking for the best ways to keep machining and weight down, precision and durability up.

The result of these meetings of minds? Doehler-Jarvis is die-casting 99 parts for the pinspotter. At AMF's plant, a hole may be tapped or a light finish cut made . . . but the bulk of the machining and a good deal of expense is avoided. As one AMF engineer puts it, "anytime you can eliminate machining today, you're certainly saving money."

Cutting costs for customers, big and little, is a Doehler-Jarvis specialty. Some of the best-known makers of automotive, electrical, communication, household, and office equipment count on Doehler-Jarvis to help them take full advantage of the die casting process.

You can count on Doehler-Jarvis, too...to apply to your problem the savvy in die design and parts production developed in our 50 years in this business. Call us in early in the planning stage.

Doehler-Jarvis Division

of

National Lead Company

General Offices: Toledo 1, Ohio

*Reg. U. S. Pat. Off.

KLIXON PROTECTED MOTORS

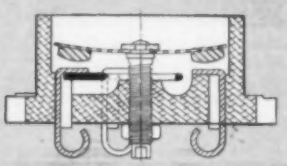
...used for over 15 years on "TACO" Water Circulating Pumps to assure dependable operation

Illustrated is a Taco Water Circulating Pump manufactured by Taco Heaters Incorporated, Providence, R.I. The motors used in these units have built-in Klixon Protectors to prevent motor burnouts. Here's what Mr. R. T. Schoerner, Chief Engineer, has to say about Klixon...

> "We have been using motors equipped with Klixon Overload Protectors on our circulating pumps for more than 15 years. We have found these protectors to be unusually dependable for this tough service."

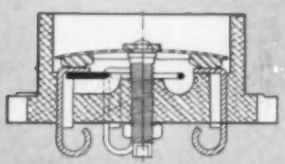
As a user of electric motors, you can keep your equipment operating, cut motor repair and replacement costs by using motors with built-in Klixon Protectors. The additional cost is low... pays for itself in short order.

HOW KLIXON PROTECTORS PREVENT MOTOR BURNOUTS



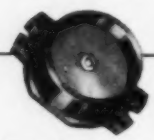
CLICK... IT'S OFF!

When the temperature within the motor reaches the danger point, the Klixon Protector snaps the power "OFF," prevents a burnout.



CLICK... IT'S ON!

As soon as the motor cools to a safe operating temperature, the Klixon Protector automatically snaps the power "ON" again... or by pushing the red button when the manual reset type is used.



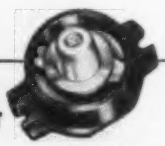
Automatic Reset

KLIXON

SPENCER THERMOSTAT

Division of Metals & Controls Corporation

906 FOREST ST., ATTLEBORO, MASS.



Manual Reset

Here's a Thermostat Metal that takes a shower *and Likes it!*

TRUFLEX® J7 Thermostat Metal Resists Water Corrosion

It's natural for a duck to take to water. And it's natural for General Plate *Truflex* J7 Thermostat Metal to operate without corrosion in water. Take for example the shower mixing valve illustrated. This and similar coils have operated continuously in showers and hot water tanks for over 15 years without failure due to corrosion.

Other *Truflex* J7 Thermostat Metal coils are operating successfully in such applications as hot water temperature measuring valves, tanning applications which often operate in mild acids, radiator valves and the like.

You, too, can obtain constant and accurate performance in your products because General Plate fabricates to your exact specifications, complete *Truflex* thermostat metal units ready for installation. You get reliable performance because every order comes to you an exact duplicate of the original . . . consistently uniform in tolerances, temperature reaction and performance, thus preventing rejects and costly adjustments in assembly.

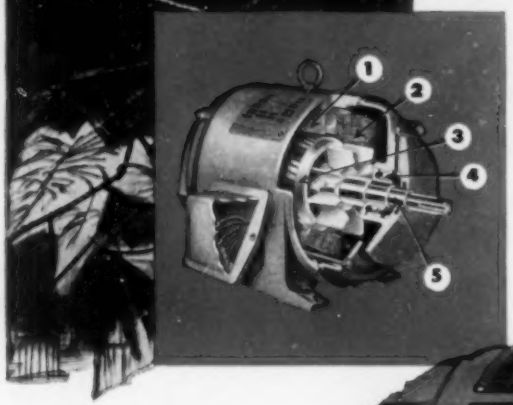
For you who desire to manufacture your own parts, *Truflex* Thermostat Metals are available as strip in coils or flat cut lengths. Write for engineering assistance and catalog.

METALS & CONTROLS CORPORATION
GENERAL PLATE DIVISION
16 FOREST STREET, ATTLEBORO, MASS.

It mastered the moisture of **MALAYA**

...BROOK MOTORS can meet your moisture conditions, too!

Windings are highly resistant to moisture, heat, oil and electrical strain! Every Brook motor is built with mica-insulated stator slots and windings that are impregnated and baked to resist moisture conditions encountered in the U. S. and in every corner of the world! These world-respected AC motors are designed and precision built to meet or *surpass* NEMA standards for size, rating, service and performance. Easily serviced in *any* shop . . . parts quickly obtainable everywhere. Ideally suited for original equipment manufacturers, as replacement motors, and for products destined for export. Whatever *your* needs, insist on Brook the world's *most respected* motor—built by the world's *most experienced* manufacturer.



1. **Ceramic-coated stator laminations** provide excellent dielectric qualities and maximum resistance to heat.
2. **Stator slots insulated with mica-coated fabric**—highly resistant to water, oil, heat and electrical strain.
3. **Dynamically-balanced rotors** to eliminate vibration . . . a practically indestructible unit of pure copper or aluminum passing through rotor laminations.
4. **U. S. standard interchangeable ball bearings** in metric sizes. Mountings protected against dirt and moisture.
5. **Precision-ground shaft**—painstakingly ground to the highest, most exacting standards. Made of the finest, high tensile steel.
6. **All major types**—available from stock . . . open drip-proof, splash-proof, totally enclosed non-ventilated, totally enclosed externally fan-cooled . . . in a wide range of horsepower sizes.

Write for FREE catalog!

Get all the details about the complete Brook line . . . write today!

BROOK MOTOR CORPORATION
3555 W. Peterson Avenue, Chicago 45, Illinois

BROOK MOTOR CORPORATION

1904-1954
... respected and used the world over for 50 years!

THINNEST, STRONGEST OF ALL PLASTIC FILMS

new Du Pont MYLAR

REG. U.S. PAT. OFF.

DOES AN AMAZING VARIETY OF JOBS BETTER

Strongest of all plastic films! An exceptional tensile strength, one-third the strength of steel, is just one of the properties of "Mylar" that may help you improve your product.

Balance of properties offered by "Mylar" permits insulation that takes up less space . . . resists extremes of temperature and humidity.

Attractive patterns printed on "Mylar" may be bonded to acoustical tile. This decorative surface is easily cleaned . . . actually improves acoustical efficiency.

High tensile strength and dimensional stability of "Mylar" make it useful for a variety of recording and industrial tapes.

New possibilities of product improvement—in fields as far apart as electrical capacitors and high-fashion fabrics—are opened by Du Pont "Mylar" polyester film. This new product of Du Pont research offers an unusual balance of electrical, physical, chemical and thermal properties. Its tensile strength of 23,500 p.s.i. permits its manufacture in gauges as thin as ¼ of a mil (0.00025 inch).

"Mylar" has a high dielectric strength and a relatively low power factor. These properties, together with its outstanding mechanical properties and thermal stability, make it ideal for a variety of insulating purposes.

Chemically inert, solvent-resistant and moisture-insensitive coverings result when "Mylar" is laminated to aluminum foil, kraft, and asbestos papers. These laminations form a tough, durable vapor barrier . . . an easily applied, cost-cutting protection for thermal insulation.

If you would like to evaluate the possibilities of "Mylar" for improving your own products, send for your copy of a new booklet that shows where this versatile film's properties can be used to advantage. Write to: E. I. du Pont de Nemours & Co. (Inc.), Film Department, Room No. 2P, Wilmington 98, Delaware.

DU PONT "MYLAR"

Polyester Film

DU PONT

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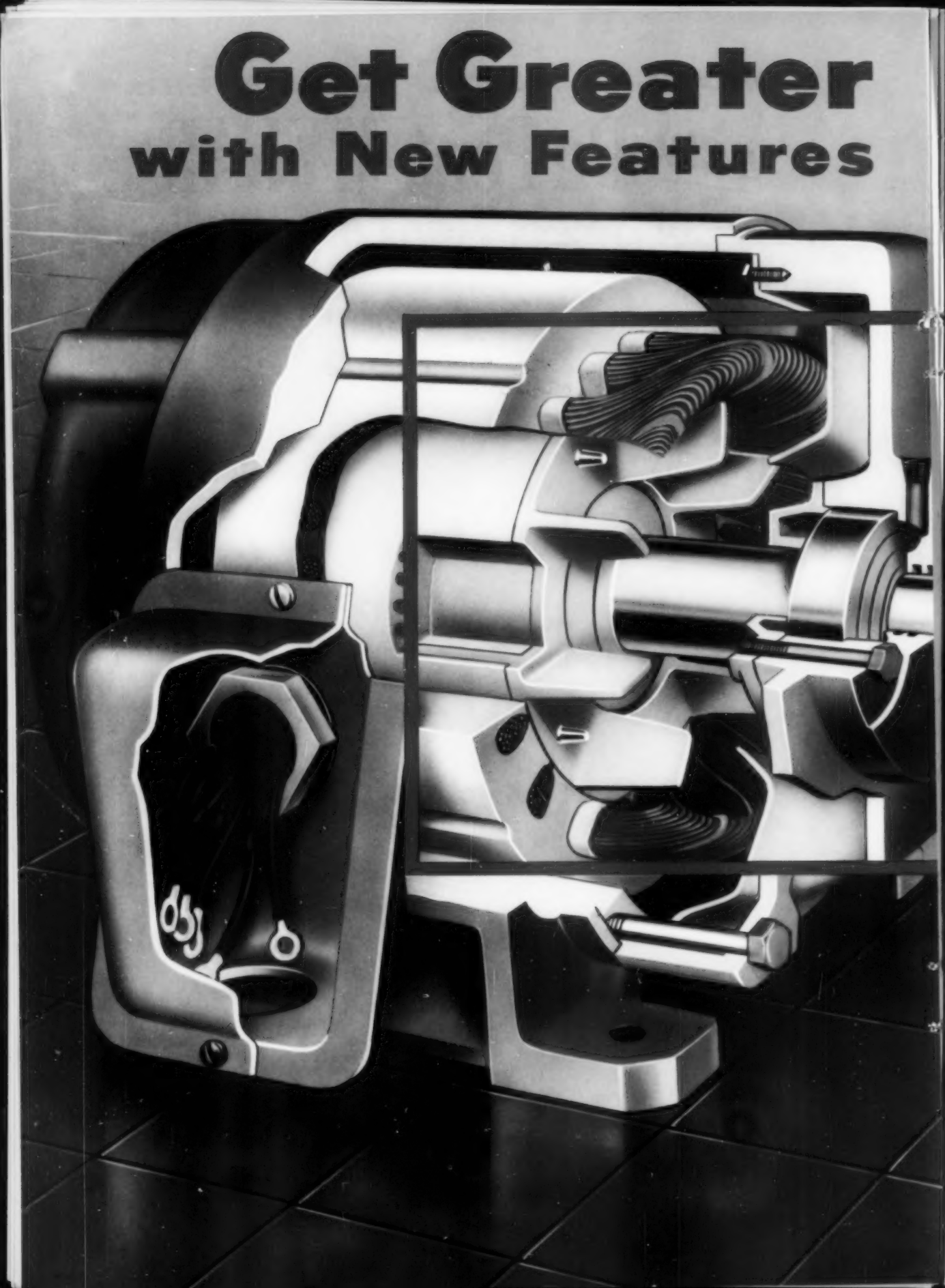
BETTER THINGS FOR BETTER LIVING . . . *THROUGH CHEMISTRY*

Get Greater
with New Features

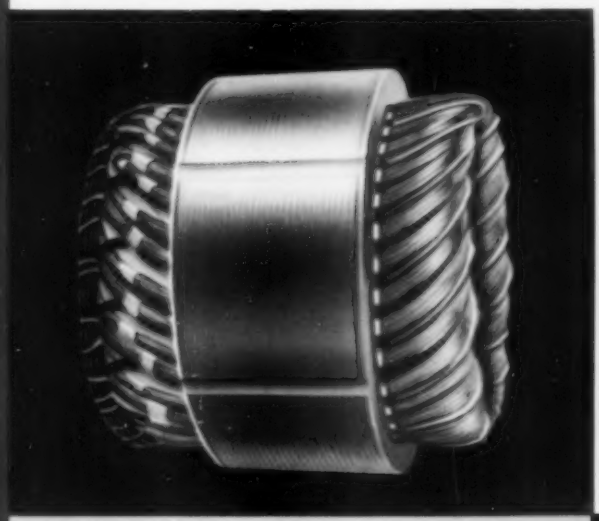


Motor Economy
. . . Proved Principles

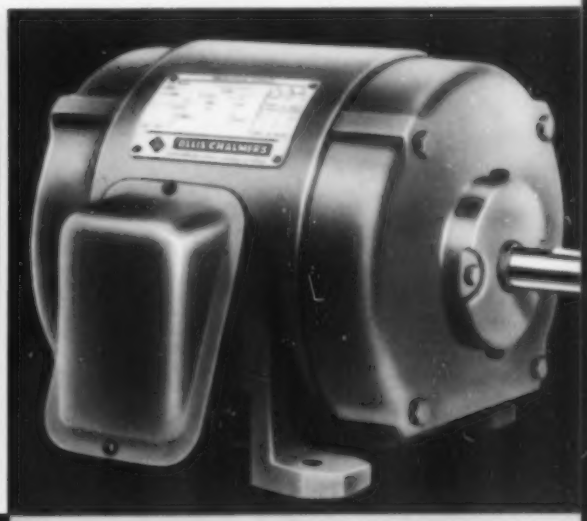
Here's the inside story of a great new motor. It combines the best of the new developments in methods and materials with the best of the tried and proved principles that have made such an outstanding record for Allis-Chalmers motors.

Smaller in size than previous designs, it offers greater protection against damage from falling liquids and solids. The bearing design gives greater bearing protection, ease of maintenance and long life. Insulation gives you famous Allis-Chalmers rugged dependability.

Consult your nearby Allis-Chalmers Authorized Distributor or District Office on your motor needs. Or write for Bulletin 51B6210.



STATOR DOUBLE INSULATED—Stator laminations are welded across back for rigidity. Heavy varnished cambric insulation is inserted between phase windings. Wound stator is dipped several times in special insulating varnish of proved effectiveness and stamina, and baked after each dip. The Allis-Chalmers stator is both physically and electrically strong . . . thoroughly protected against moisture, heat and corrosion.



RIGID CAST-IRON FRAME—Heavy, distortion-free cast-iron frame holds bearings in rigid alignment . . . gives all-around protection against physical damage . . . resists rusting.

Air intakes are well protected by being located on the underside of the end housing. There is plenty of room for free air circulation on the back of the stator core for efficient, even cooling. Air is discharged horizontally and to the sides.

Multiple bearing protection keeps grease in... keeps dirt out...permits relubrication in service

Extreme care has been taken to provide longest possible bearing life and lowest possible maintenance costs. The bearing itself is of double-shielded type, which allows controlled migration of grease in and out of the bearing to suit operating conditions. Yet bearing is protected against greatest cause of bearing trouble — overgreasing.

Close running clearances and double labyrinth seals between the shaft and outer bearing housings keep grease in the bearing and exclude dirt. Grease is kept out of the interior of the motor by a bearing cap with a long running clearance along the shaft. The cap is held tightly in place by hex head cap screws. Large grease chambers hold an ample supply of lubricant.

A-4362

ALLIS-CHALMERS

MILWAUKEE 1, WISCONSIN

Making dryers dry better

The insulation on an automatic clothes dryer is almost as important as the heat that does the drying. Effective insulation not only reduces the loss of heat from the drying area, increasing the efficiency of the dryer, it also keeps the outside of the dryer cool, making the entire unit more practical.

To be certain that the insulation stays in place, designers of the Hotpoint clothes dryer specified a 3M adhesive, EC-404.

This adhesive can be applied quickly and easily. It holds the insulation firmly in place as soon as contact is made—even on tricky, contoured surfaces. And EC-404's rubber-like film holds securely even when hot, assuring long-lasting, satisfactory service for users of the Hotpoint clothes dryer.

See what adhesives can do for you . . . If bonding together two similar or dissimilar materials is one of your problems, look to 3M for the effective and economical answer. Your local 3M sales engineer will be glad to consult with you. Call him in . . . or, write today for free informative booklet—to 3M, Dept. 46, 417 Piquette Avenue, Detroit 2, Mich.

see our catalog in PRODUCT DESIGN FILE or write for copy

3M COMPANY

ADHESIVES AND COATINGS DIVISION **MINNESOTA MINING AND MANUFACTURING COMPANY**

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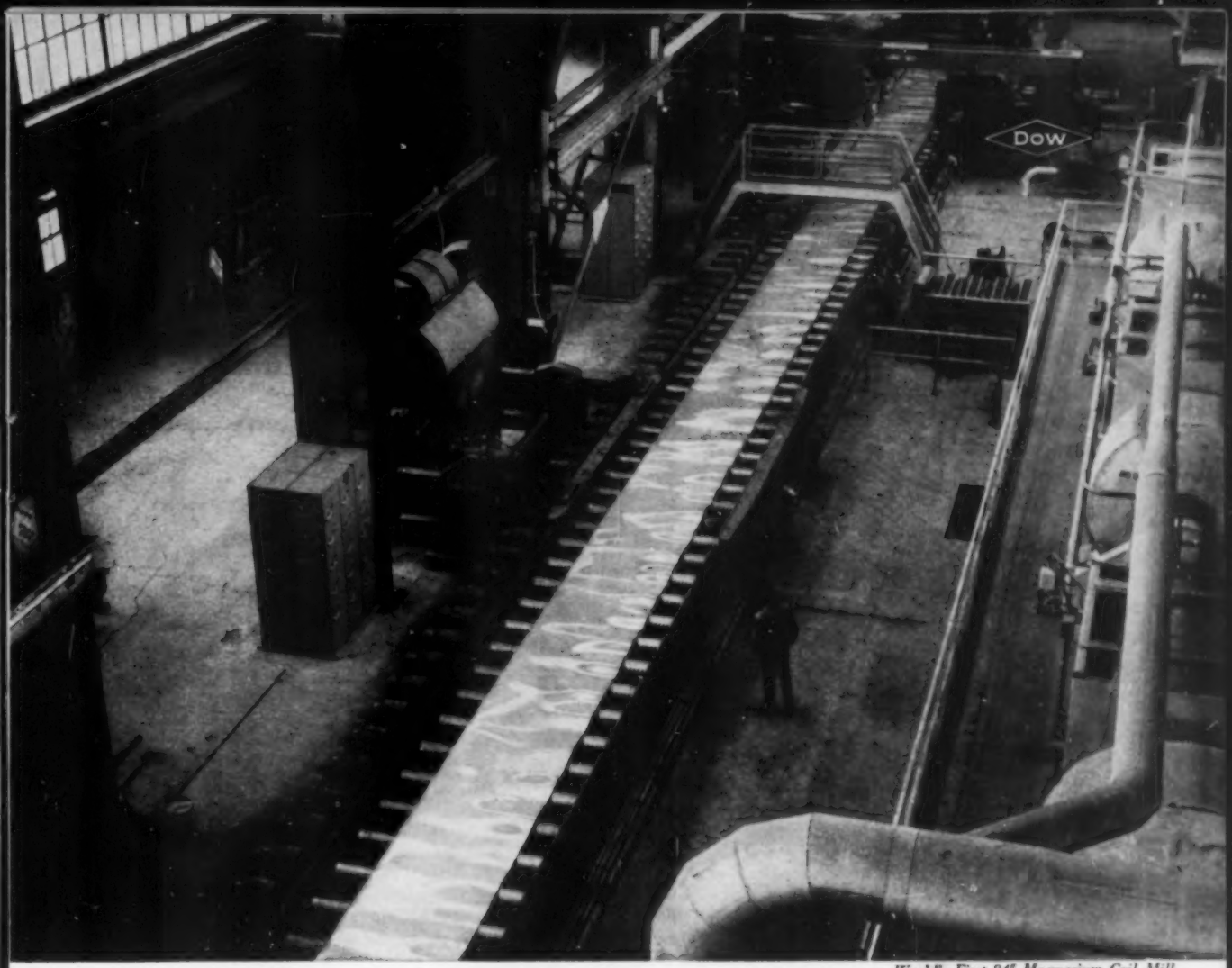
MAKERS OF "SCOTCH" BRAND PRESSURE-SENSITIVE ADHESIVE TAPES • "SCOTCH" BRAND SOUND-RECORDING TAPE • "SCOTCHLITE" BRAND REFLECTIVE SHEETINGS • "3M" ABRASIVE PAPER AND CLOTH • "3M" ADHESIVES AND COATINGS • "3M" ROOFING GRANULES • "3M" CHEMICALS



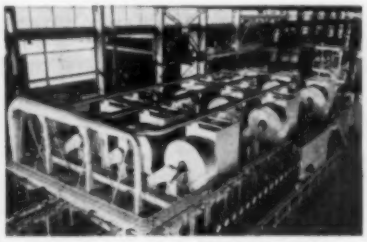
World's First 84" Magnesium Coil Mill.

a new look at Magnesium!

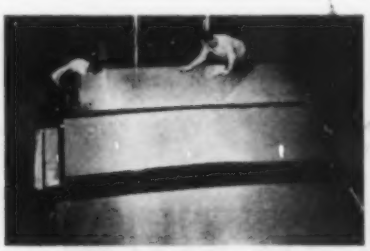
UP TO 25% PRICE REDUCTION ON SHEET AND PLATE

New Dow facilities—now in operation—are producing magnesium sheet in *quantity*. Wider, longer—magnesium sheet now offers a brand new challenge to designers, engineers, manufacturers. To cut costs, to save weight, to add strength—to do revolutionary new things for many products—get the new magnesium story! Call the nearest Dow sales office or write THE DOW CHEMICAL COMPANY, Magnesium Department, Midland, Michigan.

Here for the first time, large magnesium rolling ingots weighing nearly a ton are being rolled.



Specially designed, carefully controlled ovens pre-heat huge magnesium ingots just before rolling.



Constant inspection plus rigid production controls assure uniform magnesium sheet quality.

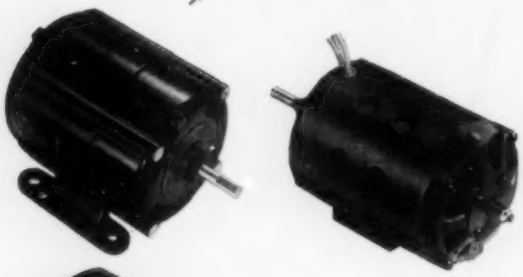
Note how coil of magnesium sheet illustrates new availability in greater widths and lengths.

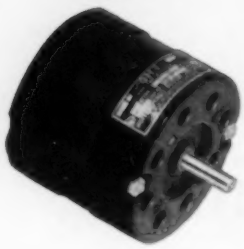
you can depend on DOW MAGNESIUM

DOW

got a problem?

we're specialists in fractional H. P. motors!





Universal and D.C. Motors
1/1000 to 1/2 h.p.
Shaded Pole Motors
1/2000 to 1/8 h.p.
Induction Motors
1/1400 to 1/4 h.p.

Fractional H. P. motor applications require individual solutions—there are rarely two applications that are exactly alike. That's why Howard makes a wide range of motors in Universal and Direct Current, Shaded pole, Induction motors, Gear motors, Blowers and Dynamotors. Because of this flexibility, Howard fractional H. P. motors offer a likely solution to your motor problems.

Our experience has been gained from building motors for more than 85,000 applications. To mention a few of the hundreds of applications currently in our shop, motors for—air conditioners, accounting machines, beacon lights, coin operated devices, dictating machines, facsimile equipment, electronic equipment, projectors, hedge trimmers, portable power tools, instruments, sewing machines, tape recorders and many more.

To get the complete facts on Howard fractional H. P. motors, write or phone (Racine 2-2731) today. Please address Chief Sales Engineer.

DEPT. PE-8 • HOWARD INDUSTRIES, INC. • RACINE, WISCONSIN

DIVISIONS: EMC ELECTRIC MOTOR CORPORATION
CYCLOHM MOTOR CORPORATION RACINE ELECTRIC PRODUCTS

CHECK HOWARD FOR QUANTITY APPLICATIONS TODAY

What are the 4 key factors in selecting a gasket material?

You'll find them in this newly revised gasket manual

17 helpful sections, including:

- **Designing flanges for efficient sealing**
- **Sealing with confined resilient gaskets**
- **Designing gaskets to reduce costs**
- **Effect of gasket widths on compression**
- **Relation of gasket thickness to load**
- **Design problems peculiar to rubber gaskets**
- **Effect of surface conditions on gaskets**

FREE FOR YOUR FILES

When you want to find the *four key factors* in selecting a gasket material, or need to know what Armstrong materials meet current specifications, see "Armstrong's Gasket Materials." Newly revised for 1954, this 24-page manual offers data essential to anyone concerned with gaskets or joint design. It includes suggestions on gaskets and joint design . . . gives details on various types of gasket materials . . . and offers important specification data. See it in Sweet's product design file, section 3h. For your FREE COPY, fill in and mail the coupon below.

SEND COUPON TODAY

Armstrong Cork Co., Industrial Div.,
7106 Irvin St., Lancaster, Pennsylvania

Please send me your new 24-page gasket manual.

Name _____

Company _____

Address _____

_____ *Position* _____

ARMSTRONG'S GASKET MATERIALS

HOW THEY ADDED YEARS TO THE BOOM'S LIFE

Many a sidewalk superintendent has winced at the beating taken by excavating equipment, like this trench hoe built by Hanson Clutch & Machinery Co., Tiffin, Ohio. It takes a rugged boom and stick, for example, to absorb those jarring impacts and straining lifts day in, day out, with no downtime for repairs.

Wanting their product to stay on the job even in tougher-than-usual service, the Hanson people turned to Mayari R high-strength, low-alloy steel. They found that Mayari R, with its yield point of 50,000 psi, built a much stronger boom and stick than carbon steel, without increasing the weight. One of these Hanson units, operating with an oversize bucket, recently completed six years' service with its boom and stick still in excellent condition.

Mayari R can be fabricated and welded as easily as carbon steel, with the same equipment and methods. Tests show that its resistance to atmospheric corrosion is five to six times better than that of carbon steel. These and other facts about Mayari R are detailed in our new Catalog 353. Get in touch with the nearest Bethlehem sales office for a copy.

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

BETHLEHEM STEEL

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. *Export Distributor:* Bethlehem Steel Export Corporation

Mayari R *makes it lighter... stronger... longer lasting*

CHEMICAL RESISTANCE

GREASE RESISTANCE

FLEXIBILITY

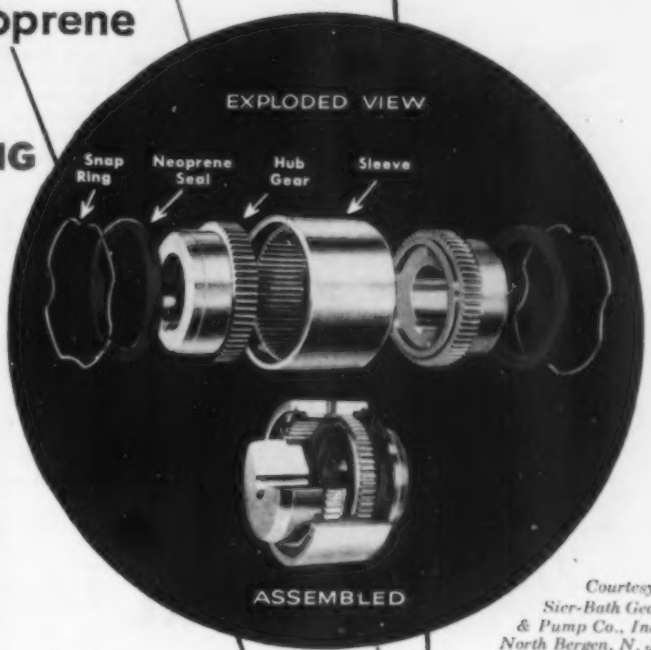
These properties of neoprene make a better

FLEXIBLE GEAR COUPLING

This new design in flexible gear coupling has greatly simplified the job of connecting the shafts of driver and driven machines. The assembly consists of two geared hubs (one keyed to the driving shaft, the other to the driven shaft), a sleeve with an internal gear cut in it, two neoprene-asbestos seal rings, and two snap rings.

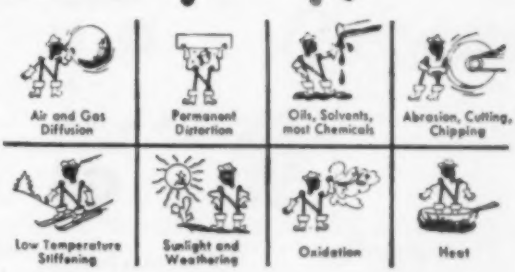
Here's how it works. The internal gear in the sleeve slides over and meshes with the hub gears, transmitting torque from driver to driven hub. Hub gears are slightly rounded to permit the coupling to take up $1\frac{1}{2}°$ angular misalignment. The neoprene seals slide over the shank of the hubs and inside the sleeve, retaining grease in the coupling and excluding dirt and corrosive materials. Snap rings hold these seals in place and keep the sleeve from drifting off the hub gears. Since the flanges needed in conventional couplings are eliminated, size and weight are cut 40 to 50 per cent by this new design.

Neoprene was specified to assure long service life for the sealing rings. It resists both the lubricant inside the sleeve and corrosive fumes outside. In fact, tests have proved that the neoprene seals perfectly even against chlorinated and aromatic hydrocarbons. Performance such as this has given Du Pont neoprene an important role in a wide variety of design innovations and improvements.



Courtesy: Sier-Bath Gear & Pump Co., Inc. North Bergen, N. J.

PROPERLY COMPOUNDED NEOPRENE WILL RESIST:



NEOPRENE

The rubber made by Du Pont since 1932

DU PONT

BETTER THINGS FOR BETTER LIVING . . . *THROUGH CHEMISTRY*

***FREE!* THE NEOPRENE NOTEBOOK**

Each issue shows new, unusual applications of neoprene . . . new products . . . improved designs. The neoprene application cited above is covered in detail in Notebook No. 57. Add your name to the mailing list today.

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Rubber Chemicals Division PE-6, Wilmington 98, Del.

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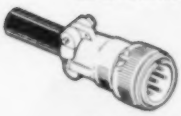
AN

AN Series . . . conforming to Specification MIL-C-5015B. 15 diameters and 260 insert layouts. 6 shell styles, AN3100 to AN3108. Plastic inserts.



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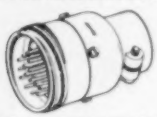
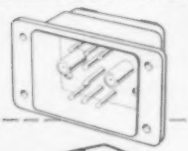
AN-E Series . . . environment resisting. Meets Specification MIL-C-5015B. *Completely sealed from cable to cable.* Integral cable clamp. New grounding lugs. Improved sealing grommet and new grommet follower. Resilient inserts in two types.



For General Circuitry in More Rugged Applications

K, RK

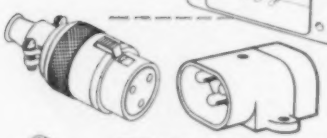
K, RK Series . . . *Special Acme thread.* Rugged. 8 basic shell shapes, 8 diameters, and 204 catalogued insert layouts. The all-purpose, quality line.



For Rack-and-Panel Chassis Applications

DP

DP, DPB, DPD, DPD2, DPD2R, DPR, DPA (miniature), and DPM Series . . . rectangular in shape with many insert layouts in DPB and DPD.



For Audio

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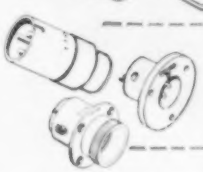
P and O Series, the original microphone series . . . 22 shell styles and 7 insert layouts. "P" plugs in steel.



For Microphone and Low Level Circuits

X, XK, XL

X, XK and XL Series . . . 23 basic shell styles and 8 insert layouts for cord-end or wall mounting.

For Instruments and Radio Circuitry

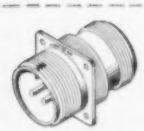
D, U

Sub-Miniature Connectors . . . The D and U Series for cord-end, rack-and-panel, or wall-mounted applications. The D Series has 3 basic shapes, up to 50 contacts. The hermetically-sealed U Series, cylindrical with 4 basic shell sizes, accommodates up to 12 contacts in 12 insert layouts. DH Types used for hermetically-sealed miniature components.

For High Pressure Applications

GS

Hermetically-Sealed Connectors . . . with steel shells and contacts to withstand high pressures. Available in the GS, KH, DH, and U Series. Insulation is a vitreous material, fused under high temperature to shell and contacts, thus forming a true hermetic seal.



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STEEL SHELL FIREWALL

AN-K and Cannon K Firewall or High Temperature Connectors . . . offer you the greatest variety of this type of connector. Cannon made the first firewall connector and is still the leader in the field. Wall- or box-mounting receptacle. Straight or angle 90° plugs. Crimp-on contacts . . . no solder to melt. Inserts of asbestos-filled or glass-filled material.

Please Refer to Dept. 106

CANNON ELECTRIC COMPANY, 3209 Humboldt St., Los Angeles 31, California. Factories in Los Angeles; East Haven; Toronto, Canada; London, England. Representatives and distributors in all principal cities of the U. S. A.

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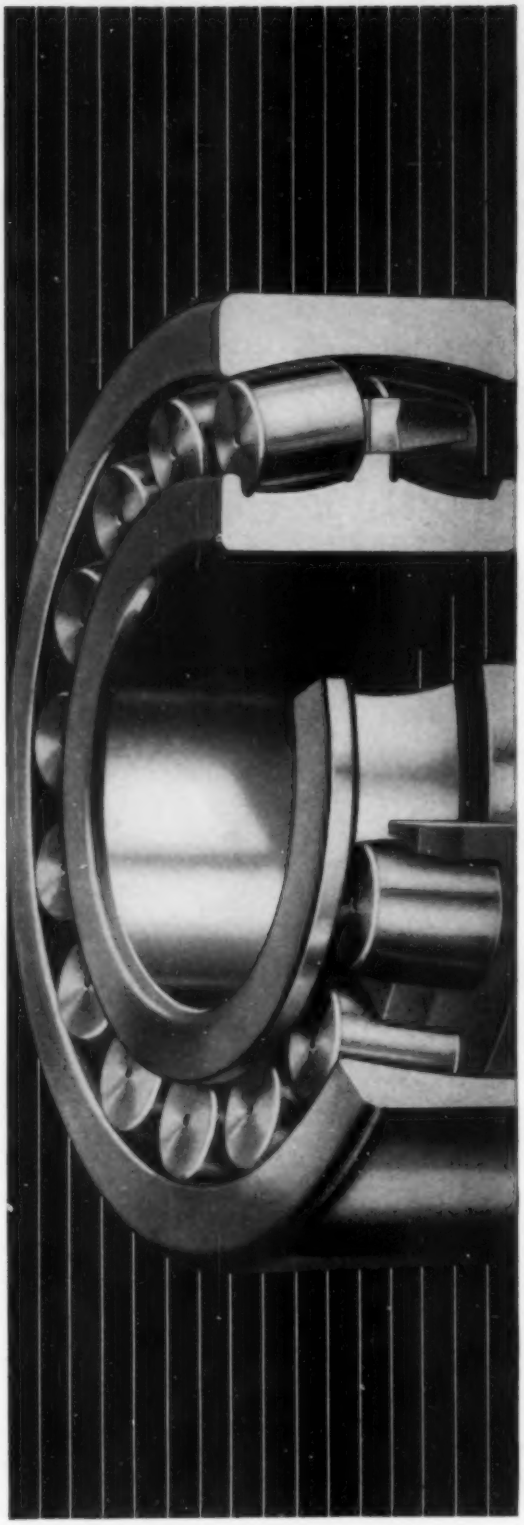
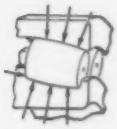


why it pays to specify

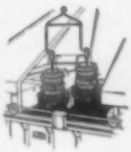
TORRINGTON

Spherical Roller Bearings

Uniform, close control of precision-ground contact surfaces—for even load distribution and maximum bearing life.



Accurate geometrical conformity between races and rollers—for ultimate load carrying capacity and performance.



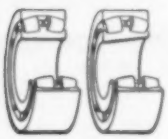
Races and rollers heat treated according to the most advanced metallurgical procedures—for maximum durability.

Individual one-piece cage for each path of rollers—assures freedom of operation.

Integral flange on inner race—to give radial stability and positioning for thrust loads—both essential to satisfactory performance.

Self-aligning—for continuous, free-rolling service under shock loads and at sustained speeds.

Unit assembly—for easy, economical handling.



Available from stock with either straight or tapered bore—for shaft or adapter mounting.

These are advantages that give you long, efficient, low-maintenance service in the toughest heavy-duty application. **To get maximum value for your bearing dollar,** ***specify TORRINGTON Spherical Roller Bearings.***

THE TORRINGTON COMPANY

South Bend 21, Ind. • Torrington, Conn.

TORRINGTON *SPHERICAL ROLLER* **BEARINGS**

Spherical Roller • Tapered Roller • Cylindrical Roller • Needle • Ball • Needle Rollers

Here's the WAY to do it..

Model 3040 Kaukauna Horizontal Drilling and Tapping Machine. 73"x7" railslide ways are Ampco Grade 8 Metal.

Kaukauna Machine Corp.

Kaukauna, Wisconsin

Product: Kaukauna Horizontal Drilling and Tapping Machine Model 3040.

Problem: To find a railslide way material that would provide dependable life in a tough service application. It had to resist high bearing pressures and maintain the close tolerances required in machine tool service. Wear was a problem — the slide travels at speeds up to 100 inches per minute. The material also had to provide superior bearing qualities to operate satisfactorily against the semi-steel bed casting.

Solution: **AMPCO METAL**

Results: The Ampco Metal ways show practically no wear in this tough, continuous service. That's how Ampco Metal helps Kaukauna guard its reputation for dependable operation and top-grade output.

And that's why you find Ampco Metal at critical points in all types of machine tools — wherever wear and high bearing pressures are factors.

IT'S PRODUCTION-WISE TO AMPCO-IZE!

Sand-cast water wheel — 12,000 lbs.

Extruded solids, hollow rounds, and shapes.

Kaukauna Machine Corporation fights wear and high bearing pressures

with

AMPCO* METAL

In Milwaukee stock — Grade 24 solid rounds, rectangles, centrifugally-cast die blanks.

THE ability to stand up year after year in tough machine-tool service proves that Ampco Metal can really take it.

And Ampco Metal — a series of special alloys — adds longer life to both your product and production equipment, gives you lower costs, less grief. Here's why:

Ampco Metal has high compressive strength — won't squash out. It has remarkable resistance to wear in all its forms — abrasion, corrosion, erosion, cavitation-pitting, etc. Ampco Metal gives you high impact and fatigue values — makes a superior bearing material. That's why it is often called "the Metal without an Equal."

Ampco Metal is easy to use — available in practically any form you need. You can get it in sand and centrifugal castings, sheet, plate, fittings, and fasteners. Also available as forgings, tubes, bars, extruded shapes, and welding electrodes and wire.

Perhaps Ampco Metal is the answer to wear, shock, load, and many other troublesome problems you face. Let it help you to build greater customer satisfaction into your product, or to obtain higher production, lower costs, longer runs in your plant. Get complete information on any application from your nearby Ampco field engineer or write us.

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Clutch ring — Centrifugally-cast.

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9-24

Ideal for mildly corrosive service

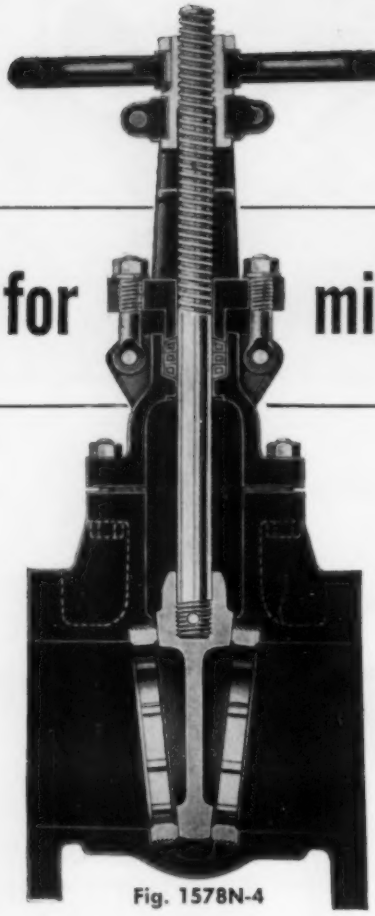

Fig. 1578N-4

3% Nickel Iron Gate Valve, Class 125 lb. . . . for process industries . . . developed and produced by The Lunkenheimer Co., Cincinnati 14, Ohio. Outside screw and yoke, bolted bonnet, flanged . . . face to face dimensions are American Standard for 125 lb. Cast Iron Wedge Gate Valves (ASA B16.10-1939).

LUNKENHEIMER develops new 125 lb. nickel-iron valve for process industries...

Mildly corrosive valve service poses a particularly tough problem in the process industries. To get *maximum* corrosion resistance, you have to pay for more than you need—high-alloy valves are expensive. And yet, ordinary cast iron often won't do the job.

An economical answer to many of these problems has been developed by Lunkenheimer with this new line of Nickel-Iron Gate Valves. Bodies and bonnets are 3% Nickel-Iron, for better corrosion resistance than ordinary cast iron, and trim is offered in choice of 18-8 (Type 316) Stainless Steel or Monel®, for maximum resistance at the point of most severe service. This combination is cutting valve costs in the petroleum field, pulp and paper, wood treating, and scores of other process industries.

This development is but one more instance that shows how nickel alloys can be used to provide significant advantages, whatever the equipment.

Many standard nickel alloyed compositions are available, making it easy to select one with extra qualities for almost any specific use. Whatever your industry, if you have a metal problem, send us details for our suggestions. Write today.

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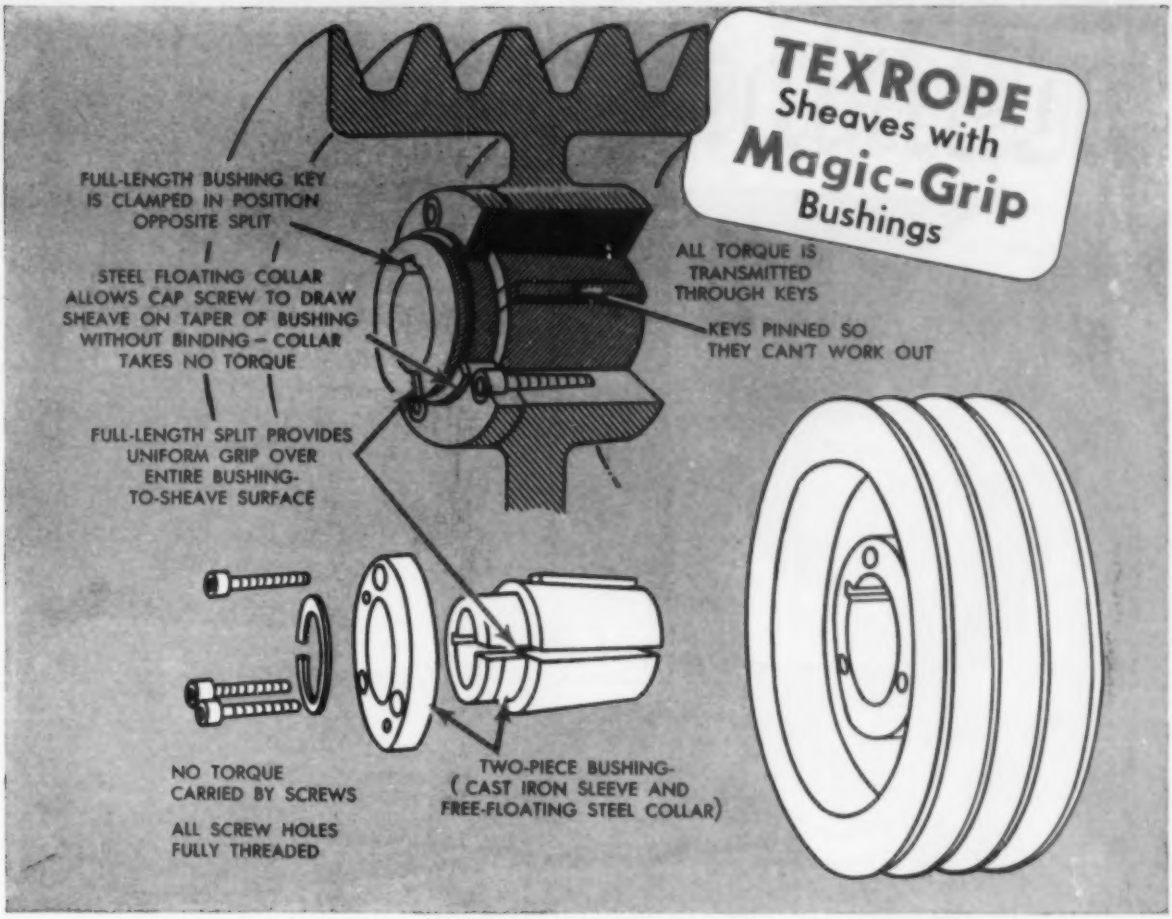
THE INTERNATIONAL NICKEL COMPANY, INC. 67 WALL STREET NEW YORK 5, N. Y.


TEXROPE
Sheaves with
Magic-Grip
Bushings
FULL-LENGTH BUSHING KEY IS CLAMPED IN POSITION OPPOSITE SPLIT
STEEL FLOATING COLLAR ALLOWS CAP SCREW TO DRAW SHEAVE ON TAPER OF BUSHING WITHOUT BINDING – COLLAR TAKES NO TORQUE
FULL-LENGTH SPLIT PROVIDES UNIFORM GRIP OVER ENTIRE BUSHING-TO-SHEAVE SURFACE
ALL TORQUE IS TRANSMITTED THROUGH KEYS
KEYS PINNED SO THEY CAN'T WORK OUT
NO TORQUE CARRIED BY SCREWS
ALL SCREW HOLES FULLY THREADED
TWO-PIECE BUSHING-
(CAST IRON SLEEVE AND
FREE-FLOATING STEEL COLLAR)

Get the **Only** Sheave with **ALL** the Most Needed Features

Here's Comparison of *Magic-Grip* Sheave and Other Sheaves

	Magic-Grip Sheaves	SHEAVE A	SHEAVE B	SHEAVE C
Bushing fully split for uniform clamping action.	Yes	Yes	No	Yes
Load carried by keys instead of threaded bolts.	Yes	No	No	No
Bushings cover full range of NEMA "probable" shaft diameters.	Yes	Yes	Yes	No
All screws engage full thread.	Yes	Yes	Yes	No
Mounts in one piece.	Yes	No	Yes	Yes
Squares itself with shaft.	Yes	No	No	No

A-4167

Texrope and *Magic-Grip* are Allis-Chalmers trademarks.

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AlSiMag® 576

AN ECONOMICAL HIGH STRENGTH ALUMINA CERAMIC

Meets L-5A Requirements of JAN-I-10 Specifications

GAS PRESSURE AND VACUUM TIGHT
UNIFORMLY LOW THERMAL EXPANSION
EXCEPTIONAL STRENGTH
HIGH INSULATING RESISTANCE OVER A WIDE TEMPERATURE RANGE
LOW DIELECTRIC LOSS

Note These Advantageous Properties

PROPERTY		UNIT	ALSIMAG 576 L-5A
Water Absorption			Impervious
Specific Gravity			3.4
Density		Lbs. per cu. in.	.123
Standard Body Colors			White
Alternative Body Colors			Pink 513 (L-5A)
Safe Temperature at Continuous Heat		°C. °F.	1 100 2 012
Hardness		Mohs' Scale	9
Thermal Expansion Linear Coefficient		Per °C. 25-700°C.	7.5×10^{-6}
Tensile Strength		Lbs. per sq. in.	20 000
Compressive Strength		Lbs. per sq. in.	140 000
Flexural Strength		Lbs. per sq. in.	40 000
Dielectric Strength (step 60 cycles) Test discs ¼" thick		Volts per mil	250
Volume Resistivity at Various Temperatures	25°C.	Ohms per centimeter cube	$>10^{14}$
	100°C.		2.0×10^{13}
	300°C.		5.0×10^{10}
	500°C.		1.0×10^{8}
	700°C.		3.0×10^{6}
	900°C.		4.0×10^{5}
Te Value		°C. °F.	800 1 472
Dielectric Constant	60 Cycles		8.4
	1 M.C.		8.3
	10 MC.		8.2
	100 MC.		8.1
Power Factor	60 Cycles		.0013
	1 MC.		.0007
	10 MC.		.0007
	100 MC.		.0008
Loss Factor	60 Cycles		.011
	1 MC.		.006
	10 MC.		.006
	100 MC.		.006

QUICK DELIVERY IN ANY DESIRED QUANTITY. AlSiMag 576 parts can be made in the full range of sizes, designs and processes that are normally available in other AlSiMag ceramics.

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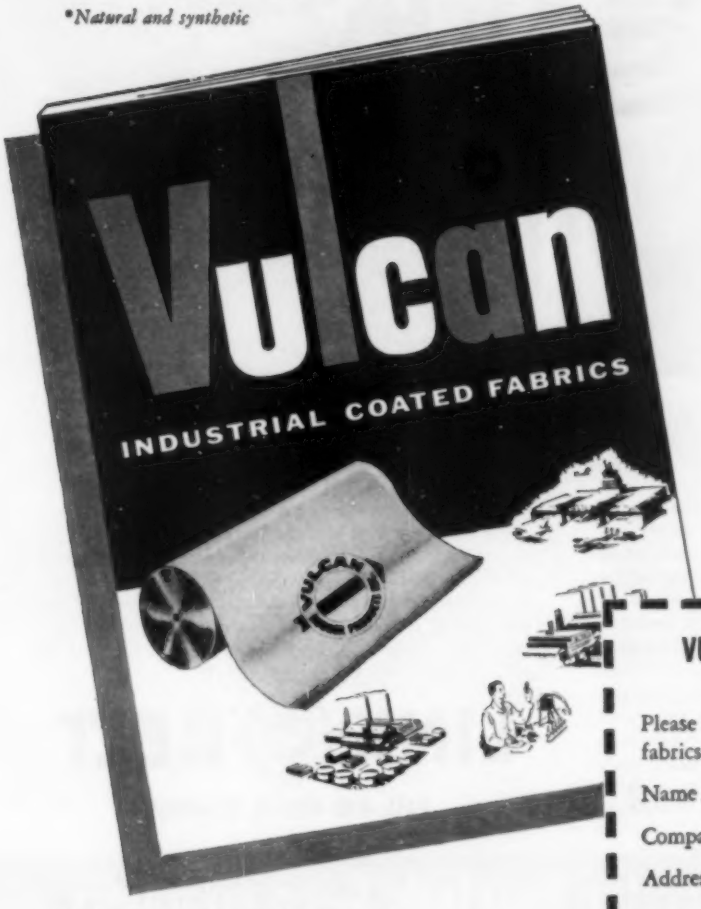
Vulcan has been making industrial coated fabrics since 1910. The list of satisfied users reads like a "Who's Who of American Industry"—including the United States Government. The new Vulcan catalogue not only details the great diversity of fabrics available but also contains useful specification data. Send in the coupon today for your copy.

**Natural and synthetic*



Vulcan coated fabrics are the modern materials for—

- Air seals
- Bearing seals
- Cable wrapping
- Carrying cases
- Carburetors
- Control diaphragms
- Covers and paulins
- Fuel containers
- Fuel pump diaphragms
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- Hospital sheeting
- Insulation
- Meter diaphragms
- Railroad car seals
- Regulators
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- Soundproofing
- Transmission seals
- Vacuum pumps

Many of the items for the above uses are produced to meet the specifications of AMS 3270, AMS 3274-A and MIL. C 8068 Type I

Manufacturers of Vulcan-Duroflex products
A subsidiary of Reeves Bros. Inc.

VULCAN RUBBER PRODUCTS, INC.
54 Worth Street, New York 13, N. Y.

Please send your new Catalogue of industrial coated fabrics to:

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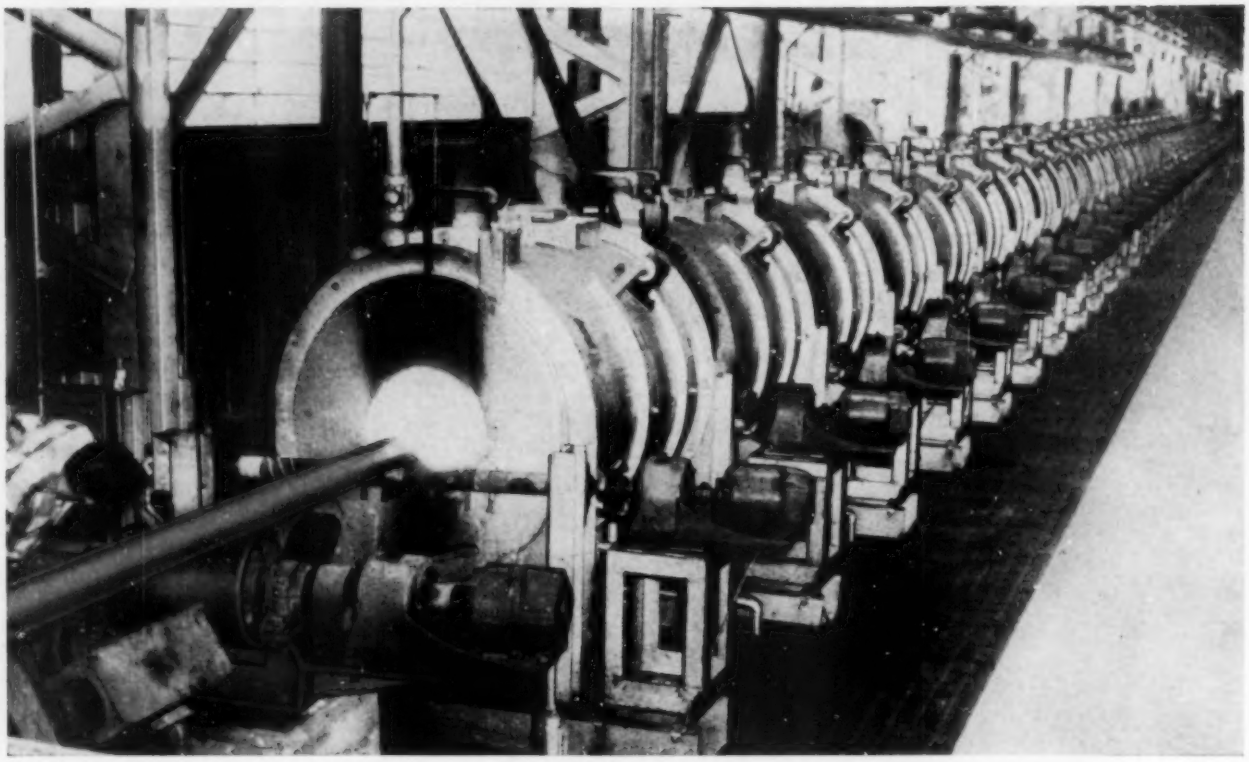
P-6

TOUGH JOB?

Texas' newest pipe mill at Lone Star Steel chooses



As far as the eye can see—Link-Belt roller bearing steel pillow blocks and helical gear drive units are used on Enterprise roller conveyors in No. 2 Pipe mill handling up to 6" dia. pipe. The No. 1 mill handles up to 16" dia. pipe. Helical gear drives are also used on the Selas normalizing furnaces and on Sutton rotary straighteners. In addition, Link-Belt chains, worm, parallel shaft, fluid and P.I.V. variable speed drives are used on cooling beds and transfer tables which were also constructed by Link-Belt.

HIGH temperatures from heat-treating furnaces . . . heavy, continuous loads . . . frequent, severe impact. You'd have a hard time finding a tougher set of conditions for bearings. Yet that's exactly the combination encountered by the roller conveyor units in a pipe mill.

Three equipment manufacturers, who were awarded separate contracts for important conveying and handling equipment, independently specified Link-Belt bearings. This selection in all three cases was approved by the designing and supervising engineers, A. J. Boynton and Company. Throughout the half-mile long production lines in Nos. 1 and 2 pipe mills, these rugged blocks with *steel housings* support the rolls and the pipe as it is formed, sized, straightened, threaded, tested, inspected, varnished and moved to yard storage.

For your toughest shaft support jobs, it will pay you to investigate the possibilities of these self-aligning roller bearings housed in steel. You'll discover the features listed on the page at right are just a few of their outstanding advantages. Ask your nearby Link-Belt sales representative for Mill Bearing Book 2565. For facts on entire line, get Book 2550.

LINK-BELT

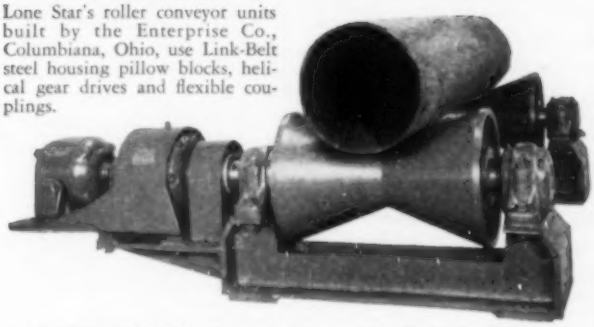
BALL AND ROLLER BEARINGS

LINK-BELT ball and roller bearings keep company with

READY ANSWER:

LINK-BELT BEARINGS

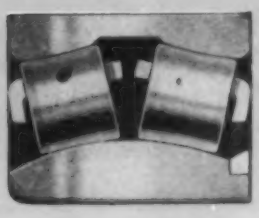
Lone Star's roller conveyor units built by the Enterprise Co., Columbiana, Ohio, use Link-Belt steel housing pillow blocks, helical gear drives and flexible couplings.



LINK-BELT COMPANY: Executive Offices, 307 N. Michigan Ave., Chicago 1. To Serve Industry There Are Link-Belt Plants and Sales Offices, Stock Carrying Factory Stores and Distributors in All Principal Cities. Export Office, New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville, N.S.W.; South Africa, Springs. Representatives Throughout the World. 13.381-DER

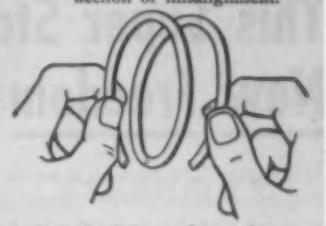
FACTS: for consulting and design engineers

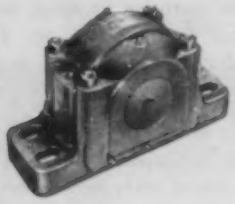
New Link-Belt Series LPK-6800-F "Mill Bearings" with Roller Bearing Pillow Blocks have rugged steel housings with removable caps for easy assembly and disassembly.



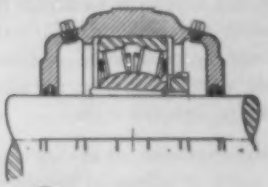
INTEGRAL SELF-ALIGNMENT. Concave rollers operate between convex raceways. Inner ring is true spherical element, free to turn in any direction without altering contact with rollers. Symmetrical rollers completely pocketed in retainers for accurate spacing and guiding. Long, care-free bearing performance is assured even with shaft deflection or misalignment.

SPIRAL STEEL SEALS provide effective lubricant retention for either oil or grease. Housing sealing fully protects all moving surfaces which are centrally lubricated from a large, common reservoir.

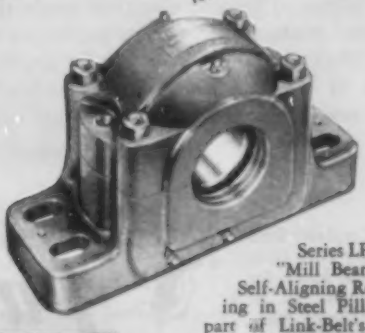




END PLATE can be used for protection where shaft terminates at the bearing. No added machining is necessary.



COMPACTNESS is achieved with self-contained design. There are no external rotating parts to mar smooth appearance.



Series LPK-6800-F "Mill Bearing" with Self-Aligning Roller Bearing in Steel Pillow Block, part of Link-Belt's complete line of pillow blocks, flanged, flanged cartridge, cartridge, take-up and hanger blocks and unmounted bearings.

America's hardest-working machines

This Super Stainless Gives You New Freedom From Corrosion!

When you're faced with a severe corrosion problem, investigate the super corrosion resistance of Carpenter Stainless No. 20. This sulphuric acid resisting Stainless can often reduce shutdown time and add substantially to equipment life.

If you are familiar with this alloy in its cast form, known as Durimet 20*, you can appreciate Carpenter No. 20's superior resistance to sulphuric acids, plating and pickling solutions, mixed acids, etc. Now that Carpenter has solved the problem of producing this Stainless in rolled forms such as bars, wire, strip and tubing, the alloy is enabling industry to add months—even years to equipment life.

Many engineers tell us they're planning now to use No. 20 as soon as possible to improve corrosion resistance in their products and reduce shutdowns. For help in your product planning work get the new Carpenter Stainless No. 20 Book. In addition, start now to discover for yourself the far-reaching advantages of No. 20. We'll be glad to provide test coupons and work with your engineering staff. The Carpenter Steel Company, 117 W. Bern St., Reading, Pa.

Export Dept.: The Carpenter Steel Co., Port Washington, N.Y.
"CARSTEELCO"

Imagine What Corrosion Resistance Like This Can Mean To You!

The problem here was to find a material that would stand up in nozzles used to fill storage batteries with electrolyte. Special fixtures were used to handle 12% sulphuric acid (specific gravity 1.080) at temperatures from 70°F to 130°F. Hard rubber nozzles broke frequently—and shutdowns for replacement often ran as high as 30 minutes. Even 18-8 Stainless nozzles, while solving the breakage problem, corroded so badly they lasted only *2 weeks* (see 18-8 nozzle on right of photo). Then Carpenter No. 20 was put to work. After they had been in use for *many months*, nozzles made from No. 20 showed no signs of corrosion (see No. 20 nozzle on left of photo).

*Carpenter Stainless No. 20 is licensed under The Duriron Company, Inc., U.S. Pats. 2,134,670; 2,185,987 and 2,200,208.

Contact The Carpenter Steel Company, Alloy Tube Division, Union, New Jersey, for Carpenter Stainless No. 20 in the forms of Tubing, Sheet and Plate.

more than corrosion resistance

Carpenter STEEL

Stainless No. 20

Pioneering in Improved Tool, Alloy and Stainless Steels Through Continuing Research

Put the powerful advantages of BAKELITE TRADE-MARK Polyethylene to work for your products

Do you need **LIGHT WEIGHT?**

Polyethylene is the lightest of all plastics. With BAKELITE *Polyethylene* you can make products easier to use, less costly to ship and handle. Look at this 2-inch water pipe. One man carries a 200-ft. coil with ease . . . no rigging needed. There's no rusting, no electrolytic action, no damage from freezing. There's high resistance to corrosion.
Imagine how many ways this lightweight, durable, and easily-fabricated material can help *you*.

Do you need **SUPERIOR INSULATION?**

BAKELITE *Polyethylene* is the superior insulating material preferred for low-loss television lead-ins. It makes wire and cable much lighter, more weather and chemical resistant. It gives your engineers a highly-adaptable material for a wide range of uses . . . as a potting resin . . . as color-coded wire and component insulation . . . for gaskets, stand-offs and scores of other electronic products. And now, BAKELITE *Cellular Polyethylene*, expanded with inert gas, offers even lighter weight, superior properties for VHF and UHF, and makes a pound of polyethylene go almost twice as far.

Do you need **FLEXIBILITY?**

BAKELITE *Polyethylene* has such inherent flexibility that no plasticizers are needed! There's flexibility with shape retention . . . for squeeze bottles of any color, with frosty, translucent, metallic or other sales-appealing finishes. It makes highly-flexible transparent film for packaging foods and scores of other products. The resins make an excellent wax additive for bread and baked-goods wrappers, providing greater strength, better heat sealing, glossier printing.

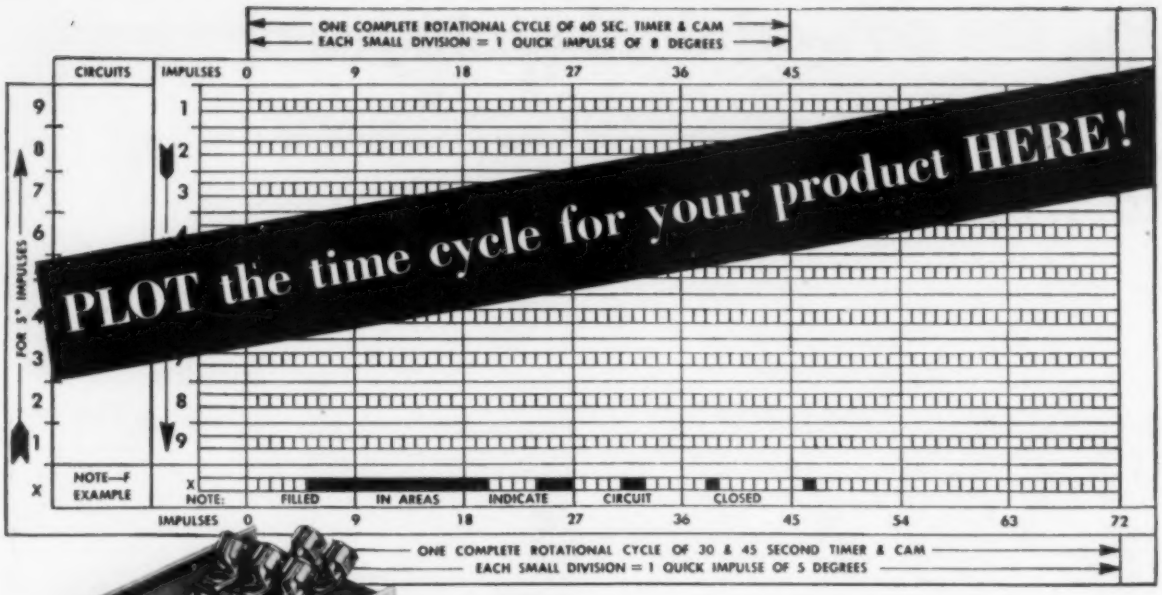
Do you need **STABILITY?**

BAKELITE *Polyethylene* is inert. It doesn't impart odor or taste. It's ideal for refrigerator containers, bowls, food packages, clothing and textile bags, and scores of other uses. In fact, it's chemically inert to almost all substances. From unbreakable carboys that safely carry corrosives . . . to spillproof and leakproof bottles for drugs . . . to chemical pipe and tubing . . . BAKELITE *Polyethylene* can help you make, sell, and distribute your products better, easier, and more profitably.

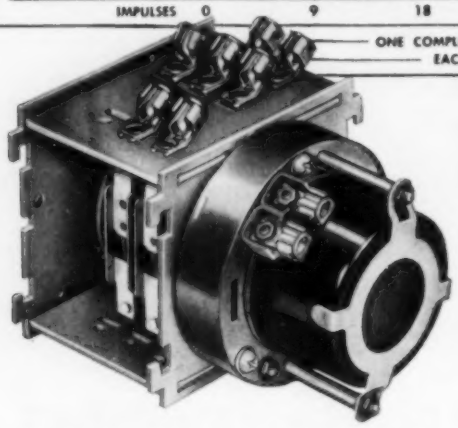
RIGHT NOW is the time to put BAKELITE *Polyethylene* to work for your present products and your products-in-mind. It can be fabricated in every way known to plastics. It offers opportunities that no one can predict until he tries it. Start investigating now by writing for our booklet, BAKELITE *Polyethylene*, to Dept. XK-10.

BAKELITE TRADE-MARK
Polyethylene

BAKELITE COMPANY, *A Division of Union Carbide and Carbon Corporation* UCC 30 East 42nd Street, New York 17, N. Y.


ONE COMPLETE ROTATIONAL CYCLE OF 60 SEC. TIMER & CAM
EACH SMALL DIVISION = 1 QUICK IMPULSE OF 8 DEGREES
CIRCUITS
IMPULSES 0 9 18 27 36 45
FOR 5° IMPULSES
NOTE—F
EXAMPLE
NOTE: FILLED IN AREAS INDICATE CIRCUIT CLOSED
IMPULSES 0 9 18 27 36 45 54 63 72
ONE COMPLETE ROTATIONAL CYCLE OF 30 & 45 SECOND TIMER & CAM
EACH SMALL DIVISION = 1 QUICK IMPULSE OF 5 DEGREES

PLOT the time cycle for your product HERE!



This Mallory Interval Timer Switch is designed so that the total time cycle can be varied from zero to as much as 72 minutes.

Operations can be controlled for intervals as short as 30 seconds and with as many as 36 operations in a 72 minute cycle.

The switch will control up to 14 different circuits and the actuation of a pilot light or buzzer signal can be included in the circuitry.

The timer switch has a 15 ampere current rating and ⅓ horsepower rating at 125 volts.

Other timer switch designs are available in both rotary and lateral form to cover time cycles up to 24 hours and more . . . with current ratings up to 25 amperes at 250 volts.

This Mallory Interval Timer Switch . . . or an adaptation of it, may answer YOUR switch problems

This versatile switch can be easily modified to handle an infinite number of circuits. The number of cams can be varied . . . the contour of the cams can be shaped to the desired time cycle programs of varying applications . . . different bussing arrangements can be incorporated to accomplish numerous circuit combinations.

If the switch on your product can be improved, be sure and get full information on the Mallory Timer Switch.

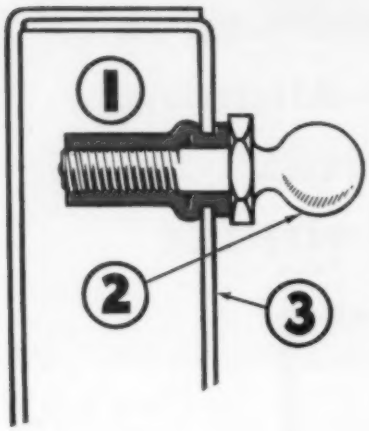
In addition to switches of this type, Mallory Push Button Switches and combined automatic timer and push button switches are available in designs that will meet the requirements of a wide variety of equipment. Our engineers will be glad to work with you on your switch design problems . . . give you the advantage of years of experience in diversified switch development and manufacturing that often permits us to produce switches for special purposes without the cost and delay of special tooling.

Expect more . . .
Get more from MALLORY

Serving Industry with these Products:
Electromechanical—Resistors • Switches • Television Tuners • Vibrators
Electrochemical—Capacitors • Rectifiers • Mercury Batteries
Metallurgical—Contacts • Special Metals and Ceramics • Welding Materials

P. R. MALLORY & CO. Inc.
MALLORY
P. R. MALLORY & CO., Inc., INDIANAPOLIS 6, INDIANA

One B. F. Goodrich RIVNUT solves 3 fastening problems!

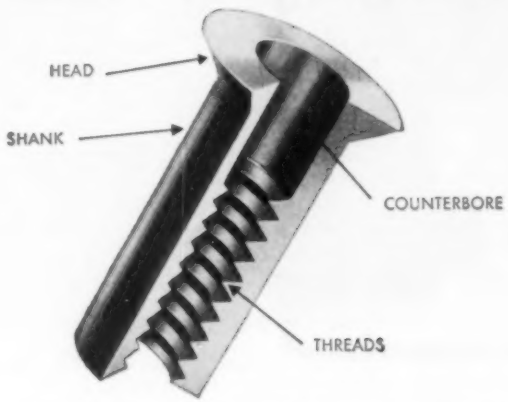


A RIVET WAS NEEDED for doors of metal cabinets that 1) could be installed from one side only, 2) would serve as a nut plate for a knob attachment, and 3) could be installed after enameling. A B. F. Goodrich Rivnut proved the perfect answer.

A flat-head Rivnut is inserted in the sheet metal door. Working from one side, one man can upset Rivnut in 2 seconds with easy-to-operate heading tool. Bulge formed in Rivnut shank grips the metal tightly. The knob of the catch is then threaded into the clean, still-intact Rivnut threads. Rivnuts are installed after enameling without marring the finish.

This simple solution saved many man-hours on the job. If you have a fastening problem, why not put it up to Rivnut engineers? Write to The B. F. Goodrich Company, Dept. PE-64, Akron, Ohio.

THIS IS A B. F. GOODRICH RIVNUT . . . . THIS IS HOW IT WORKS

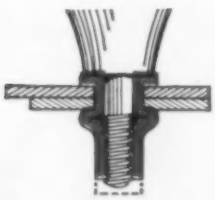


This cross-section shows the threads by which the Rivnut is threaded onto the pull-up stud of the heading tool. These threads are not injured by the heading operation and enable you to fasten *to* a Rivnut as well as *with* it.

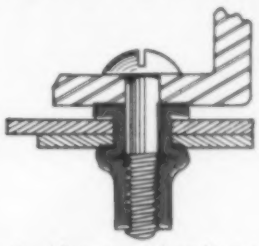
The Rivnut provides a large bearing surface, requires only a small hole, and can be installed after enameling without marring the finish.

1. Rivnut is threaded onto pull-up stud of a manual or pneumatic heading tool.

2. Rivnut is inserted, head firmly against work, tool at right angles to work.



3. Tool lever operates pull-up stud, forming a bulge in the Rivnut shank.



4. After upset, threads are still clean and intact, ready for screw attachment.

B.F.Goodrich RIVNUTS

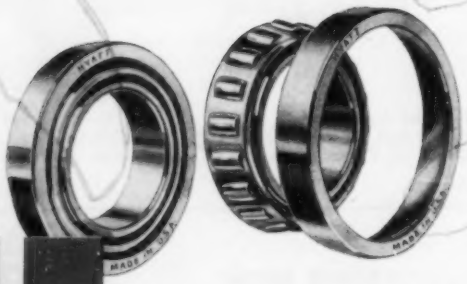
The only one-piece blind rivet with threads

SEND NOW FOR FREE RIVNUT DEMONSTRATOR

Shows with motion how Rivnuts work. Explains construction, gives proved applications. Write to The B. F. Goodrich Co., Dept. PE-64, Akron, Ohio.

Always within easy reach . .

Hyatt's New Line of Dual-Purpose, Self-Aligning BARREL BEARINGS!

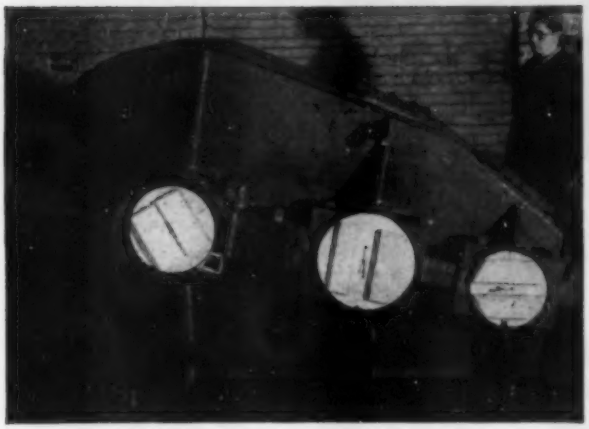


Got a bearing problem? Just reach for Hyatt's new Barrel Bearing Catalog! This is one catalog engineers have been waiting for, because it's essentially *a guide to lower maintenance costs!* Barrel Bearings are not only dual-purpose in design; they're also *self-aligning*. They operate with full efficiency under misalignment conditions which cause excessive wear in ordinary bearings. If *your* job involves bearing specifications, make sure you have Hyatt Catalog No. B-154. It puts a complete line of Barrel Bearings right at your finger tips. Write to Hyatt Bearings Division, General Motors Corporation, Harrison, New Jersey.

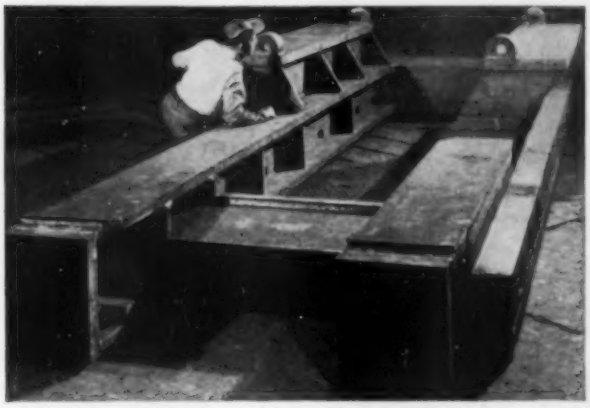
HYATT

STRAIGHT ROLLER BARREL ROLLER TAPER ROLLER

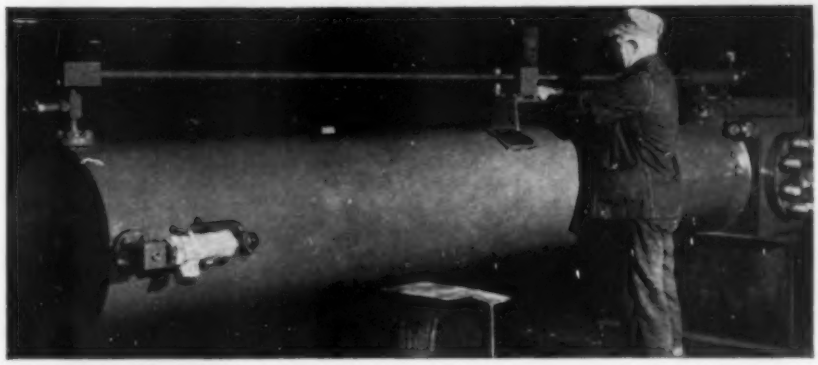
WHAT'S NEW IN WELDMENTS



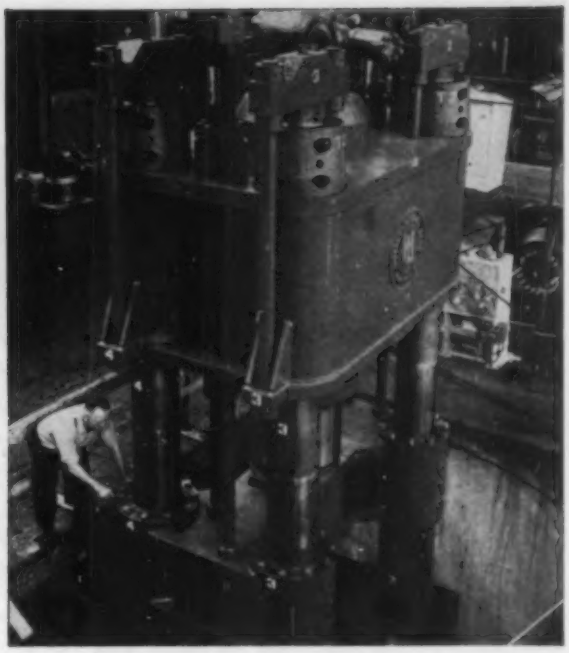
GEAR CASE—Weighing 9½ tons, this gear case is of 100 pct steel-plate construction. It was built to house the ponderous gears in a 54-in. blooming mill.



STURDY FRAME—Great strength and rigidity were required of this 21-ton weldment, the frame for a big sliding saw. Fabricated from heavy plate and structural members, it is 94 in. wide, 42 in. high and 248 in. long.



BUILT TO TAKE IT—This 15-ft accumulator bottle for a powerful hydraulic system has to handle pressures up to 1400 psi and temperatures to 600 F. It was constructed to ASME code, with forged-steel bottom valve block and head, and shell of 1¼-in. plates, all assembled by precision welding.



1500-TON FORGING PRESS—This powerful press was designed and engineered by Loewy-Hydropress, Inc. Bethlehem manufactured, machined and shop-assembled the welded, forged and cast components.

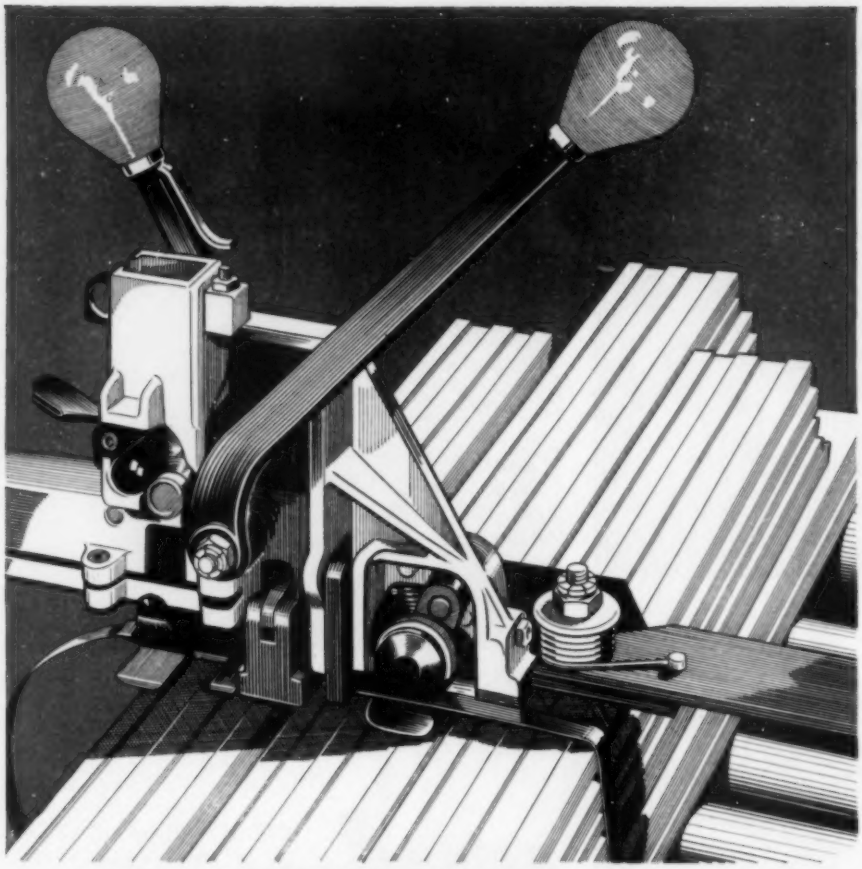
BELOW—Crosshead of the press weighs 13 tons. It was fabricated of rolled steel plates and forgings.

For further information about Bethlehem Weldments, call on the nearest Bethlehem sales office.

BETHLEHEM STEEL COMPANY
BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. *Export Distributor:* Bethlehem Steel Export Corporation

BETHLEHEM STEEL



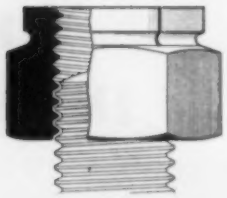
Wherever assemblies must be held together—on metal strappers or dishwashers—more and more original equipment manufacturers and maintenance men are relying on FLEXLOC locknuts for safe, dependable locking.

Why are more and more FLEXLOC locknuts being used to hold assemblies together?

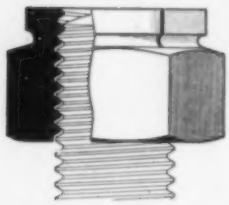
There are a number of reasons. FLEXLOCs are one piece, all metal—no lockwashers to break, no cotter pins to shear, no auxiliary locking devices to deteriorate. FLEXLOCs stay put wherever you place them—as stop nuts or seated nuts—once their locking threads are fully engaged. Because they won't work loose, they reduce costly service calls. FLEXLOCs have higher tensile, are stronger than most other locknuts. And they withstand temperatures as high as 550°F.

FLEXLOCs have the additional advantage of reusability. They can be applied again and again without loss of efficiency. Because they are safe and dependable, you'll find more and more FLEXLOCs being used where vibration is severe—on automotive equipment, compressors, machine tools, household appliances, high-speed looms, aircraft.

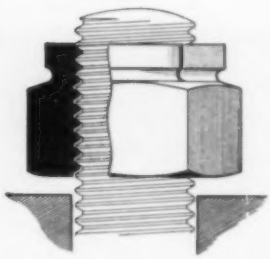
FLEXLOCs are available in a wide range of sizes in any quantity. Stocks are carried by leading industrial distributors everywhere. Write for literature and samples for test purposes. STANDARD PRESSED STEEL CO., Jenkintown 28, Pa.



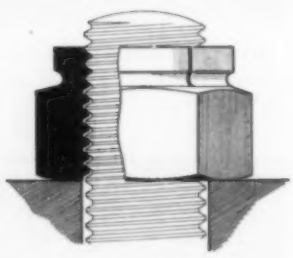
Starting. A FLEXLOC starts like any ordinary nut. Put it on with your fingers. Tighten it with a standard hand or speed wrench.



Beginning to Lock. As the bolt enters the segmented locking section, the section is expanded, and the nut starts to lock.



Fully Locked As a Stop Nut. When 1½ threads of a standard bolt are past the top of the nut, the FLEXLOC is fully locked. A FLEXLOC does not have to seat to lock.



Fully Locked As a Seated Nut. When it is used as a lock or stop nut, the locking threads of the FLEXLOC press inward against the bolt, lifting the nut upward and causing the remaining threads to bear against the lower surface of the bolt threads. Vibration will not loosen a FLEXLOC, yet there is no galling of threads.

FLEXLOC LOCKNUT DIVISION

SPS JENKINTOWN PENNSYLVANIA

New Cleveland high speed automatic gets increased precision from TIMKEN® bearings in semi-flexible mounting

DESIGNED to be the "work horse" of many shops, this 2½" Model AW automatic, built by the Cleveland Automatic Machine Company, Cincinnati, Ohio, is not only precise, it's versatile as well.

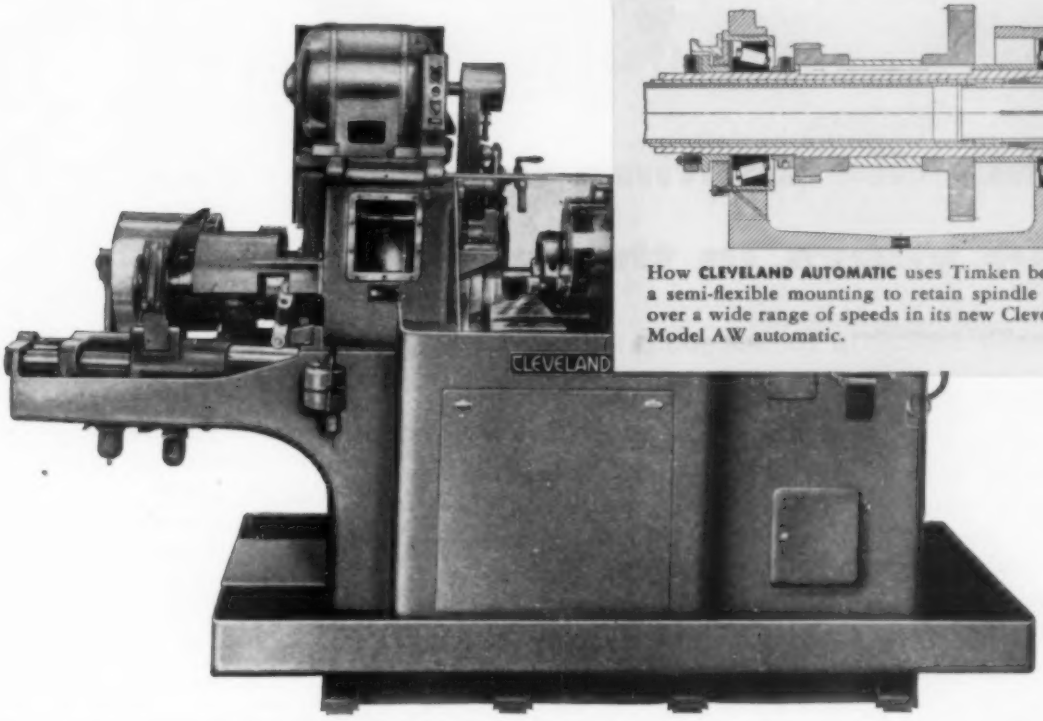
To accommodate its wide range of spindle speeds—40 in all—ranging from 69 to 1920 RPM, and to insure precision at any speed, Cleveland mounts the spindle on Timken® bearings in semi-flexible mounts. This permits any expansion during high speed operation without affecting accuracy.

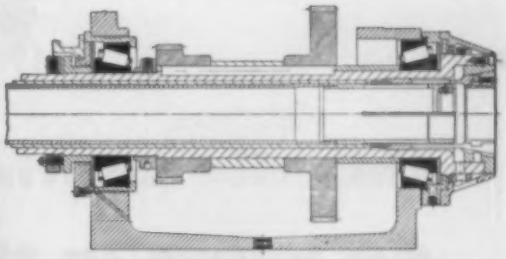
Timken tapered roller bearings hold shafts and spindles in rigid alignment. Line contact between rollers and races provides extra load-carrying capacity. Gears mesh smoothly with minimum wear under even the heaviest loads. Because of their tapered construction, Timken bearings carry radial and thrust loads in any combination.

The true rolling motion and incredibly smooth surface finish of Timken bearings practically eliminate friction. Shafts and housings are held concentric, making closures more effective.

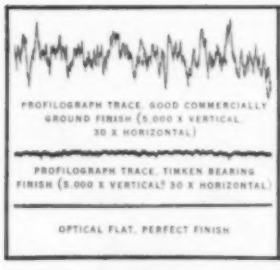
Be sure to specify Timken bearings when you build or buy machine tools. They normally last the life of the machine. Look for the trade-mark "Timken". The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ontario. Cable address: "TIMROSCO".

This symbol on a product means its bearings are the best.





How **CLEVELAND AUTOMATIC** uses Timken bearings in a semi-flexible mounting to retain spindle precision over a wide range of speeds in its new Cleveland 2½" Model AW automatic.

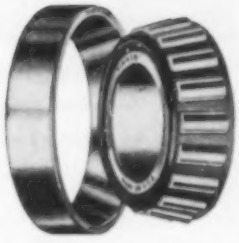

PROFILOGRAPH TRACE. GOOD COMMERCIALLY GROUND FINISH (5,000 X VERTICAL, 30 X HORIZONTAL)
PROFILOGRAPH TRACE. TIMKEN BEARING FINISH (5,000 X VERTICAL, 30 X HORIZONTAL)
OPTICAL FLAT. PERFECT FINISH

SMOOTH TO MILLIONTHS OF AN INCH

Surface finish of high quality Timken bearing rollers and races is so smooth that it takes a profilograph to measure its smoothness. This instrument measures surface variations to a millionth of an inch, as shown at the left.

TIMKEN

TAPERED ROLLER BEARINGS



NOT JUST A BALL ◯ NOT JUST A ROLLER ⬭ THE TIMKEN TAPERED ROLLER ⬭ BEARING TAKES RADIAL ⬮ AND THRUST ⬮ LOADS OR ANY COMBINATION ✳

this die casting was 44 years in the making...

● We Began "Setting Up" for This Job in 1910—and That was None Too Soon!

Slow work? Not exactly . . . it required only days to produce the casting itself. But it took 44 years of experience to gain the "know-how" needed to do the job. Why not put that experience to work for you? Whatever type of die castings you need—small or large, simple or intricate—count on *Stewart* to meet your most rigid specifications . . . on time.

SERVICES AVAILABLE . . .

Designing • Engineering • Die Making
Metallurgical Control • Most Modern Die Casting Equipment • Complete Machining, Polishing and Assembly Facilities.

44 years of helping industry to "Make It Better"

Stewart **DIE CASTING**

. . . a division of STEWART SW WARNER

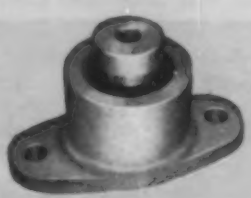
CHICAGO, ILLINOIS, 4535 FULLERTON AVENUE • BRIDGEPORT, CONNECTICUT, 275 WARREN STREET

SILENTBLOC

is a proven way to "stifle" the shakes

Shock mount to cushion and reduce magnitude of sudden shock.

Bearings and bushings for torque action and oscillating movements . . . no lubrication required.



Rolling joint type to dampen and isolate vibration, reduce noise transmission, cushion shock loads.

General Silentbloc mounts can do something about the universal plague of vibration, shock and noise in equipment ranging all the way from delicate instruments to heavy machinery.

Silentbloc mountings, bushings and bearings are being used today with outstanding success in automotive, refrigeration, industrial, aeronautical, marine, electrical, agricultural, household and dozens of other fields. These units can be custom designed and manufactured in any size and type.

For an engineered appraisal of your vibration problem send us the facts on your company letterhead. For a free design guide to vibration control fill out the coupon below.

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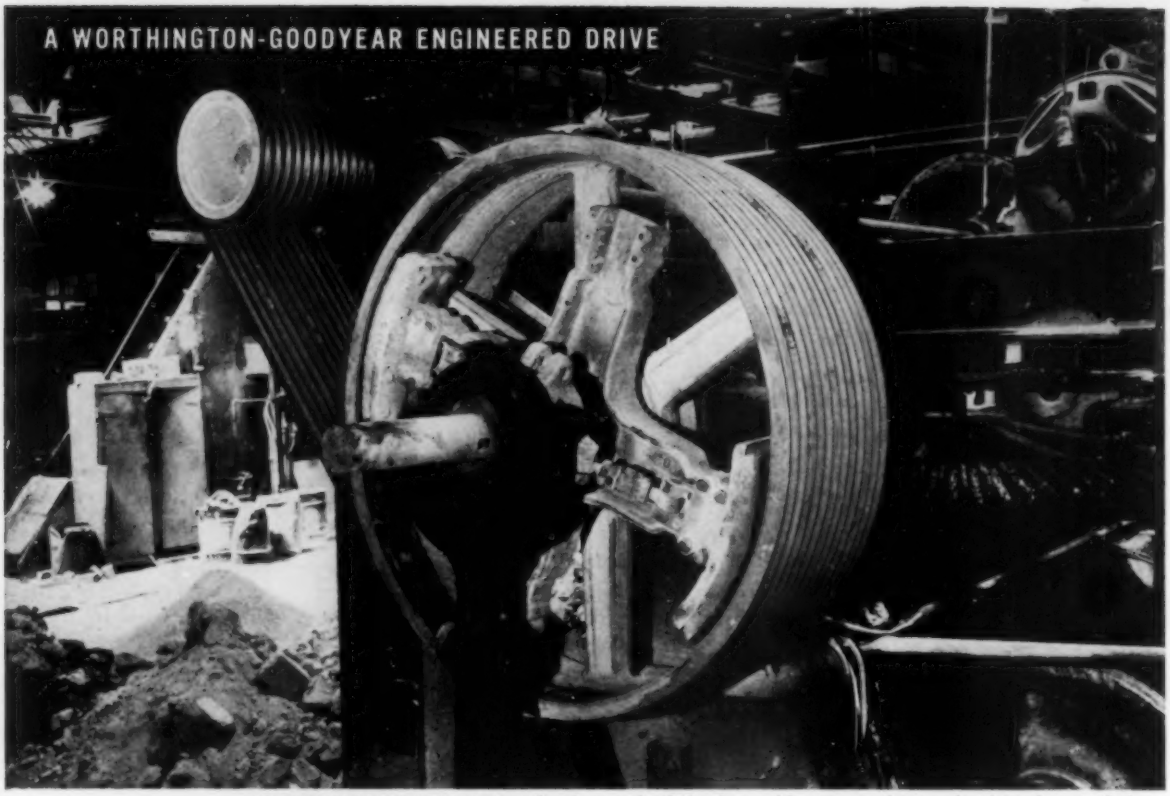
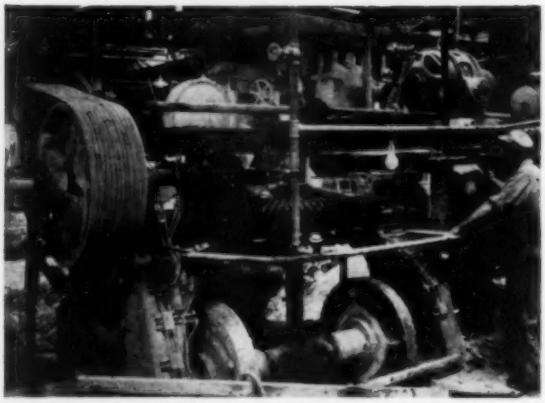


WORTHINGTON MULTI-V-DRIVE takes heavy shock loads on this wet-pan that crushes huge lumps of clay.

Belts hold as machine crushes 120-lb lumps



SMOOTH, NON-SLIP DRIVE for this wet-pan is provided by Worthington QD sheaves and Goodyear V-belts.

Worthington Multi-V-Drive solves critical drive problem

Driving a machine that crushes, mixes and tempers crude clay is a real workout for any mechanical power transmission setup—especially with lumps weighing as much as 120 pounds.

After two years of this heavy-duty operation, not one belt has been replaced on this wet-pan. And there's no noise, slippage of belts on sheaves, and no resulting power loss. Because of this fine record, Worthington Multi-V-Drives, with QD* sheaves and Worthington-Goodyear V-belts, will be installed on other wet-pan pulverizers.

Find out how this Worthington-Goodyear drive team can pay off for you, too. Write us. Worthington Corporation, Section MV.4.5, Oil City, Pa. *Reg.U.S.Pat.Off.

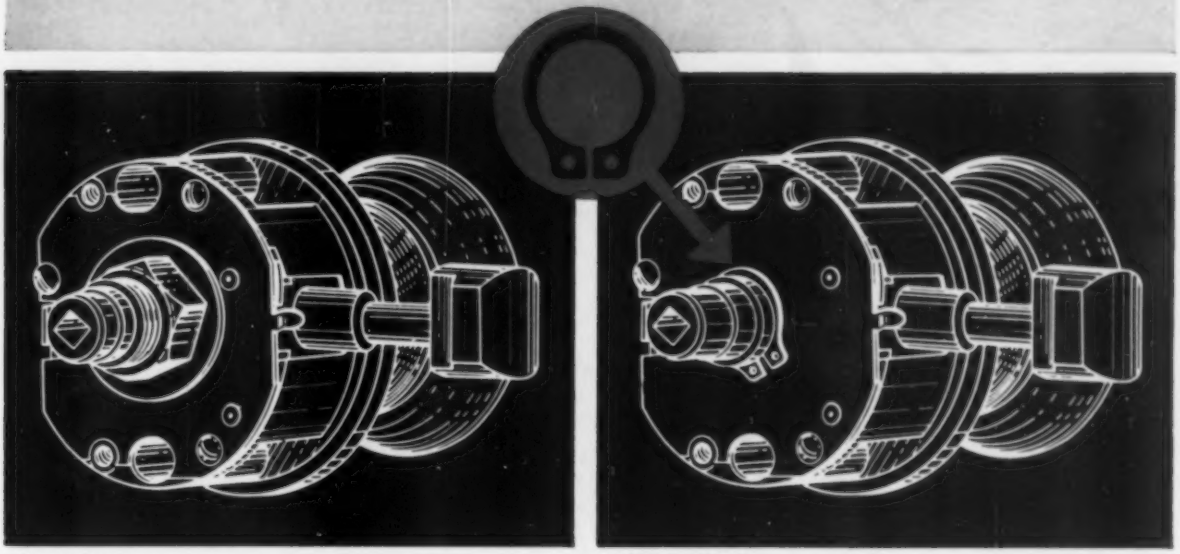
MV.4.5

WORTHINGTON

SPECIFY THESE WORTHINGTON STANDARD PRODUCTS ON *YOUR* EQUIPMENT

Compressors • Pumps • Multi-V-Drives • Variable Speed Drives

Waldes Truarc Ring Replaces Nut and Washer ...Cuts Costs $5.28 Per M...Speeds Assembly by 50%



OLD WAY. Main shaft required costly threading. Assembly was slowed by the double application of washer and nut and time-consuming tightening operation.

TRUARC WAY. Truarc Retaining Ring snaps quickly and simply over shaft. Lock assembly is secured in one fast operation. Virtually all play is eliminated from lock.

NEW DESIGN USING WALDES TRUARC RING PERMITTED THESE SAVINGS

OLD WAY

Cost of Nut	$10.00	*per thousand*
Cost of Washer	3.80	" "
Labor for Threading	2.00	" "
Assembly	3.00	" "
TOTAL	**$18.80**	

TRUARC WAY

Cost of Truarc Ring and Grooving Operation	$11.52	*per thousand*
Assembly	2.00	" "
TOTAL	**$13.52**	

J. Chesler and Sons, Inc., Brooklyn, N.Y., manufacturers of the pre-assembled "Reddi-Mount" cylindrical lockset, uses a single Waldes Truarc Retaining Ring instead of an old fashioned nut and washer to secure the entire assembly of their lock. This new, improved fastening method enables Chesler to eliminate costly threading . . . save money on material . . . speed assembly time by 50% and produce an improved, more durable product.

You, too, can save money with Truarc Rings. Wherever you use machined shoulders, bolts, snap rings, cotter pins, there's a Waldes Truarc Retaining Ring designed to do a better, more economical job. Waldes Truarc Rings are precision-engineered . . . quick and easy to assemble and disassemble.

Find out what Waldes Truarc Retaining Rings can do for you. Send your blueprints to Waldes Truarc engineers.

For precision internal grooving and undercutting...Waldes Truarc Grooving Tool

PN066

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WALDES

TRUARC

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WALDES KOHINOOR, INC., LONG ISLAND CITY 1, NEW YORK

WALDES TRUARC RETAINING RINGS AND PLIERS ARE PROTECTED BY ONE OR MORE OF THE FOLLOWING U. S. PATENTS: 2,382,947; 2,382,948; 2,416,852; 2,420,341; 2,439,785; 2,441,846; 2,455,165; 2,420,941; 2,483,380; 2,483,383; 2,487,802; 2,487,803; 2,491,306; 2,509,081; AND OTHER PATENTS PENDING.

Waldes Kohinoor, Inc., 47-16 Austel Pl., L. I. C. 1, N. Y.

Please send me the new Waldes Truarc Retaining Ring catalog.

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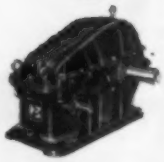

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Compact housings, specialized heat-treatment for gearing and improved accuracy of gear tooth generation mean longer, trouble-free performance. Ratios up to 360 to 1; capacities up to 1550 h.p.

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NATIONAL OIL SEAL LOGBOOK

Write our Redwood City office for reprints of this Logbook page

Sealing News & Tips

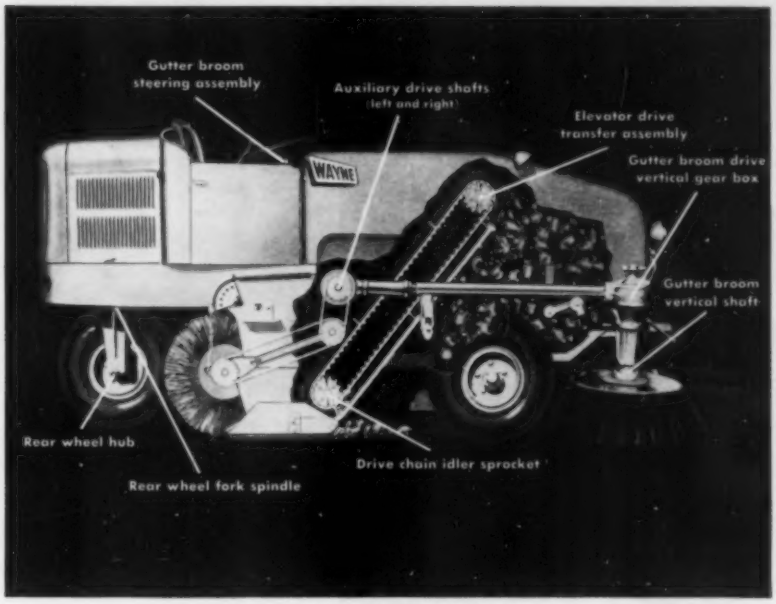
Gutter broom steering assembly
Auxiliary drive shafts (left and right)
Elevator drive transfer assembly
Gutter broom drive vertical gear box
Gutter broom vertical shaft
Rear wheel hub
Rear wheel fork spindle
Drive chain idler sprocket
WAYNE

Figure 1. Wayne Motor Pick-up Sweeper

Efficient utilization of standard-design oil seals in Wayne Motor Pick-up Sweeper

Ten National Oil Seals are used at key points to insure dependable performance and durability in the Wayne Motor Pick-up Sweeper. Each seal is of different size and shape; yet each is a mass-produced, tested and proved, standard-design National seal. Careful oil seal engineering—designing with oil seals in mind—has made possible this 100% utilization of catalog seals. As a result, Wayne's original equipment seals are readily available at low cost; and identical replacements are also obtainable at any time and at low cost.

Sealing applications on the Wayne Sweeper range from the very simple to the demanding. Among the latter is the idler sprocket position at the bottom of the rubber elevator drive chain assembly (Figure 1). Here the oil seal frequently operates under extremely severe dirt and abrasive dust conditions. Other demanding applications are at the gutter broom vertical shaft bearing, where an 18" head of oil exists; and above this point in the gear box where a head of grease must be retained.

Seals used in the Wayne Sweeper are National 50,000 series with spring-tensioned leather sealing lips and rigid steel outer cases. These seals were specified from over 2,500 standard-design National Oil Seals with leather or Syntech® (synthetic rubber) sealing members. In many cases sealing problems can be solved simply and economically through use of standard-design seals; in other applications, special seals must be designed to meet special conditions. In either event, National Application Engineers are at your service. Their special skills are backed up by the world's largest manufacturing facilities devoted exclusively to oil and grease seals.

Figure 2. National 50,000 series oil seal

National 50,000-S Syntech® Seal

For continuous operation where intermittent temperatures reach 250°F, speeds reach 3,600 F.P.M. and runout is as much as .030 indicator, National 50,000-S series Syntech seals are widely used. These seals incorporate a rigid steel outer case around a spring-tensioned synthetic-rubber sealing member which is unaffected by water and most lubricants, detergents and industrial fluids.

National O-Rings

Complete line of quality, precision-made commercial grade O-Rings. Get factory-direct engineering and sales service from the National Applications Engineer nearest you, or write direct for information and new O-Ring catalog. New Catalog includes engineering and performance information, gland groove and back-up ring design requirements, etc. Request free copy on your letterhead, giving name and position.

Oil Seal Catalog

Catalog 102-A lists most National Oil Seals. Includes springless and spring-tensioned, single and dual lip, shaft and external, leather and synthetic rubber. Request your copy today from your nearest National Applications Engineer or write direct giving your name and title.

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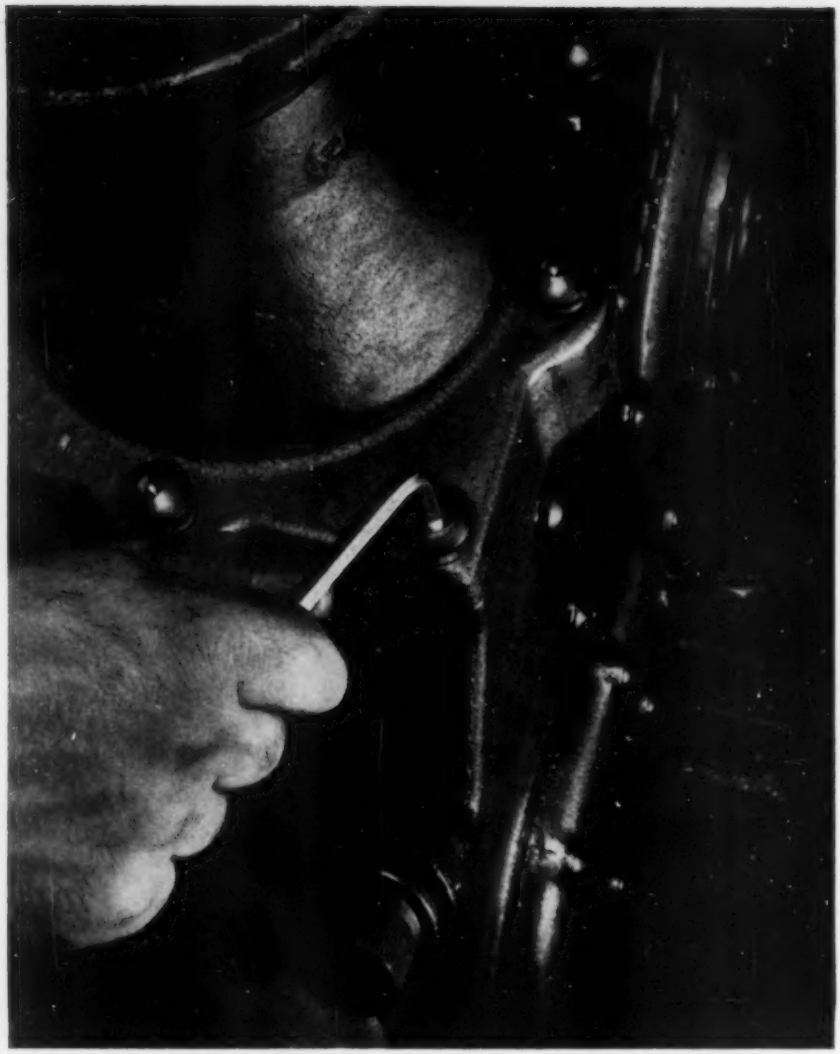
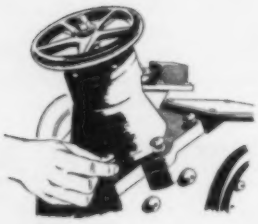
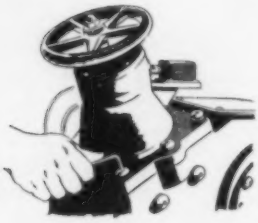


UNBRAKO **button head socket screws** are used exclusively to assemble this controlled volume pump, which was designed to fill the growing industrial need for the pumping of an allotted quantity of liquid at higher pressures, higher capacities.



The assembler inserts the UNBRAKO button head socket screw with his fingers, and runs it down as far as he can.



He then tightens it with a standard UNBRAKO key. Once seated, the low head design of the UNBRAKO button head provides a smooth, streamlined appearance.

UNBRAKO Button Head Socket Screws are made of heat treated alloy steel; have fully formed threads, Class 3 fit; are available in standard sizes from #8 to ⅝". Accurate hex socket provides nonslip drive, prevents marring or mutilation of the head.

Save inventory dollars

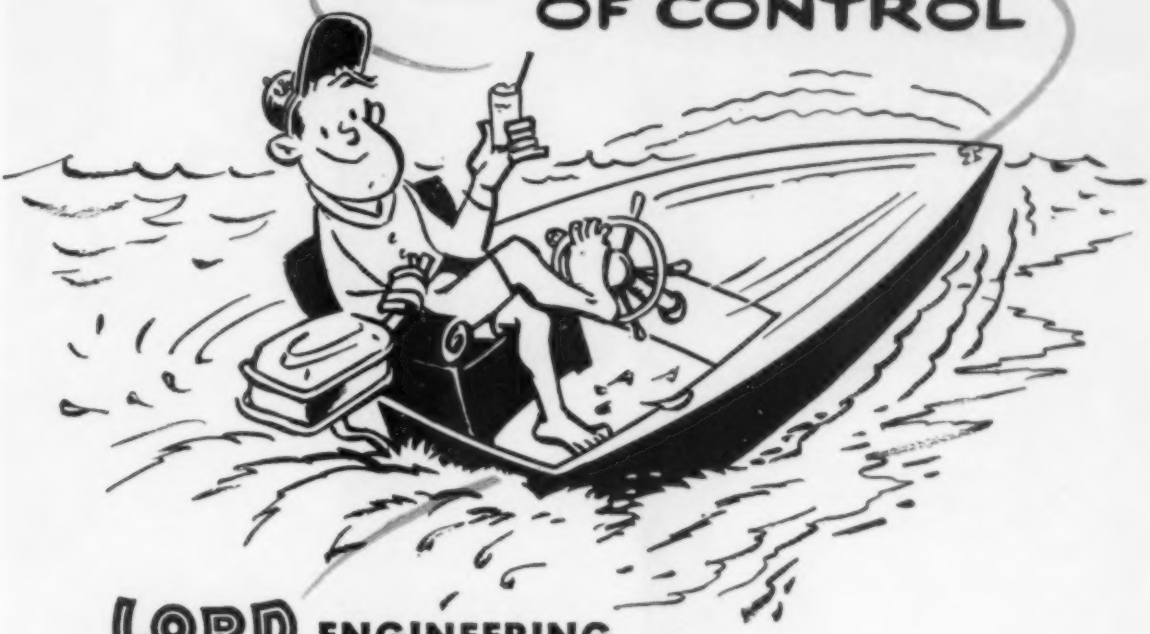
Use UNBRAKO Standards—stocked by your distributor

Not only does your UNBRAKO distributor lower inventory investment, he also saves you time—and provides latest information about products, cost-saving methods, production techniques, current problems, trade practices. For latest data on UNBRAKO standard socket screw products, consult him or write STANDARD PRESSED STEEL COMPANY, Jenkintown 28, Pennsylvania.

UNBRAKO® SOCKET SCREW DIVISION

SPS JENKINTOWN PENNSYLVANIA

JUST A MATTER OF CONTROL



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Your continuing effort to improve your products and reduce their maintenance cost may be entirely A Matter Of Control . . . the control of destructive vibration and shock. To help you to accomplish your objectives, Lord Engineering recommends the correct design, selects the most suitable elastomer and metal, and uses precision manufacturing for all Vibration Control Mountings and Bonded Rubber Parts. Your vibration and shock control problems are our business. We welcome the opportunity of placing our wide experience in many diversified industries at your disposal.

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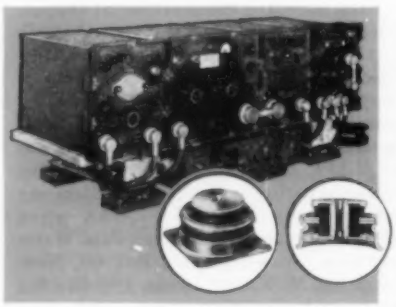

The sensitivity of many commercial and military radio transmitters is protected . . . their accuracy is insured against vibration and shock damage by Lord Vibration Control Mountings. Ask for complete details.

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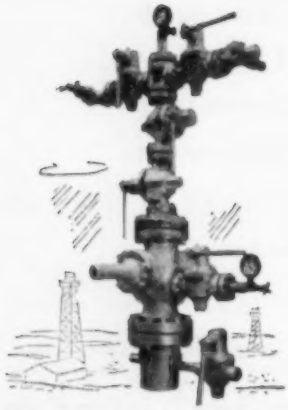
LORD BONDED RUBBER

Headquarters for **VIBRATION CONTROL** FOR 20 YEARS

Goetze V-Tite Gasket being installed on flange of new Space Saver Blowout Preventer, designed and manufactured by Cameron Iron Works, Inc., Houston, Texas.

Goetze Gaskets safeguard critical points under severe pressures



Christmas Tree made by Cameron Iron Works, Inc., is equipped with Goetze V-Tite gaskets to provide safe, tight sealing for every joint.

The new "Space Saver" Blowout Preventer made by Cameron Iron Works, Inc., of Houston, Texas, weighs only half as much as earlier equipment and takes only one-half the space. This improved design permits rig platforms to be smaller, makes possible savings on handling and materials.

For this new equipment Cameron chose Goetze V-Tite Gaskets to do the critical job of sealing Ring-Joint flanges. These precision-made gaskets withstand the high pressures encountered in oil and gas production. Goetze V-Tite Gaskets are fabricated to extremely close tolerances to secure perfect matching of rings with flange joints. They are carefully heat-treated to keep hardness below the maximum allowable. This assures proper flow of the gasket without damage to flange surfaces and reduces the necessity for undue bolt stresses.

Both standard cross-sectional shapes, the oval (Style 950) and octagonal (Style 951), seal tightly at low bolt stresses. Made to ASA-API standards, they are supplied in metals and alloys offering maximum resistance to service and temperature conditions. In addition to the ASA-API sizes, special sizes ranging from one inch to seven feet pitch diameter are available. Catalog PK-35A gives details, sizes and engineering data. Write for it to Johns-Manville, Box 60, New York 16, N. Y. In Canada, 199 Bay St., Toronto 1, Ontario.

JOHNS-MANVILLE JM PRODUCTS

Johns-Manville GOETZE GASKETS

Interested in Cost Reduction?

Design Facts

you should know about Alcoa® Aluminum Impact Extrusions

HYDRAULIC LANDING GEAR CYLINDER . . . TYPICAL OF HIGH-STRENGTH LIGHTWEIGHT PARTS . . . MASS-PRODUCED AS LOW-COST ALCOA IMPACTS

Since 1946, Alcoa has produced many millions of aluminum parts by impact extrusion. These parts have been used in business machines, textile spools, blow torches, pneumatic tools, lighting fixtures, sump pumps, fire extinguishers, calking guns, household appliances, giftware and toys, as well as countless military items.

Press techniques have steadily improved. Now we can produce complex parts that could never have been made before, except by costly combinations of alternate methods. Now, too, we can impact extrude alloys having yield strengths as high as 55,000 psi, tensile strengths up to 65,000 psi. The hydraulic cylinder shell for jet aircraft landing gear, shown here, is typical. It is produced complete in a fraction of a second, drastically reducing cost per piece by eliminating machining and assembling operations once required.

Impact extrusion, though relatively new as a means of producing high-strength parts, is essentially quite simple. Tooling consists only of a punch and die usually on a crank press. After a slug has been placed in the die—either by hand or automatically—the descending punch forces the metal to cold-flow up and around the punch, or down, away from the punch, depending on the shape desired. The finished piece has a forged base and one or more extruded side walls.

Look now at the following pages which show why designers and engineers are choosing impact extrusion as the lowest cost method of producing many complex, high-strength parts.

Many Industries Today

use low-cost Alcoa Impacts

Aluminum alone will solve many design problems. It is light weight, strong, has good corrosion resistance, high electrical and thermal conductivity, and good machinability. By impact extrusion, certain shapes possessing all of these natural aluminum advantages can be produced faster and at less cost than by any other means.

In fact, few methods can compete with this process when fabricating round, square, rectangular, cup or shell-shaped pieces with ribbed, beaded or fluted side walls. Or, parts containing bosses, lugs, recesses or other projections.

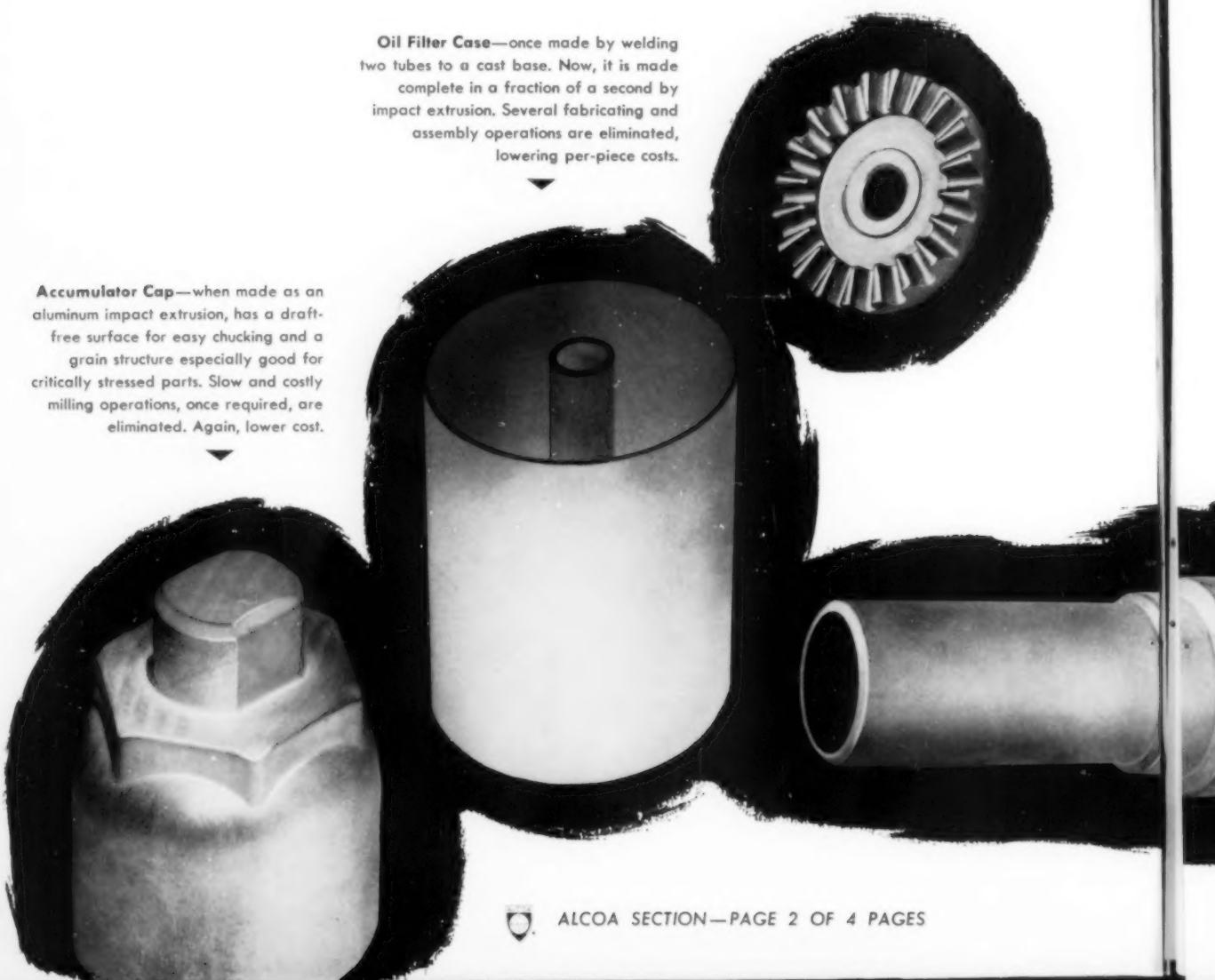
Mechanical Properties

Design requirements and mechanical properties of Alcoa Impacts are much the same as for forgings and extrusions. Surfaces are draft free, thus easily chucked if subsequent machining is required. Grain structure follows the outline of the piece, rendering it stronger than if machined from bar or rod.

Smoothness ranges between 40 and 250 micro-inches depending on the size and shape of the part, as well as the alloy selected. Alcoa Impacts are light weight, yet strong, which means high strength-weight ratios. When pay loads are a factor, high strength-weight ratios become increasingly important. Metal is efficiently distributed throughout Alcoa Impacts, making it possible to incorporate lugs, bosses or recesses with no sacrifice in strength.

Oil Filter Case—once made by welding two tubes to a cast base. Now, it is made complete in a fraction of a second by impact extrusion. Several fabricating and assembly operations are eliminated, lowering per-piece costs.

Accumulator Cap—when made as an aluminum impact extrusion, has a draft-free surface for easy chucking and a grain structure especially good for critically stressed parts. Slow and costly milling operations, once required, are eliminated. Again, lower cost.



Alloy Selection

Many aluminum alloys can be used in Alcoa Impacts beginning with commercial purity 2S, on up to alloy 75S which develops a minimum tensile strength of 75,000 psi in the fully heat-treated (—T6) temper. It is important, however, to choose an alloy that most closely matches the mechanical requirements of your product. By doing so, forming pressures can be held to a minimum, keeping production speeds higher, costs lower.

Alloy 2S is most frequently used in Alcoa Impacts because it is the easiest to impact extrude, and in addition satisfies physical and mechanical requirements for a great many applications. For higher strength, Alloys A51S and 61S, usually furnished in the heat-treated tempers, are generally preferred. When specifying these alloys, try to avoid thin side walls and bases. Reason for this is that the metal cold-flows through an orifice between the die and punch. As that orifice increases in size, less pressure is needed thus keeping production speeds high and costs down. This is even more important when the still-higher strength alloys, 14S and 75S, are employed.

Coupling Flange—used in aircraft engines was once cast. Now, as an Alcoa Impact, it is much lighter, yet stronger. Surface finish is better than as cast; tolerances are closer. Production speeds are more than doubled. Costs are lower.

Design Tips

Originally, impact extrusion was only used to produce collapsible tubes, familiar to all of us as tooth paste and shaving cream dispensers. But today, with modern press techniques and so many Alcoa-developed, high-strength alloys, impact extrusion is used for a wide variety of intricate, heavy-duty parts. Such parts either were never produced before, or could be fabricated only by expensive combinations of milling, drawing, machining or casting operations.

Just by stepping the die, for example, it is possible to increase side wall thickness at the open end of an impact as much as two times. The hydraulic cylinder shell described on the first page is a good example of this. Or, you can design your part with an expanded open end without changing wall thickness. Flutes and ribs of nearly any design can be incorporated on the inside, outside or both sides of the side wall.

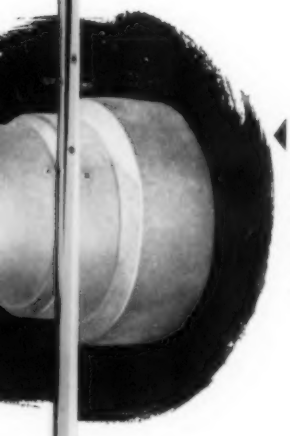
Largest of the Alcoa Impacts being produced today are 18 inches long, 6 inches in diameter. They can be round, square, rectangular, or practically any shape provided it is approximately symmetrical, but it should be kept in mind that as cross-section angles become acute, more generous fillet radii should be allowed.

Ratio of length of the part to its diameter, generally should not exceed 6 or 8:1. However, several Alcoa Impacts have been produced with length-diameter ratios as high as 12:1. Maintain symmetrical design when possible, especially if you specify higher strength alloys. Otherwise, the punch tends to deflect laterally. Minimize this by beveling the inside base of your part or centering a lug inside on the base. Concentricity, tolerances and straightness will be improved, production speeds increased, tooling life lengthened, costs lowered.

Mechanical, chemical or electrochemical finishes can be applied to Alcoa Impacts. They can be dipped, polished, satin finished, enameled, lithographed or lacquered. Or, they can be finished in any one of a whole rainbow of colors by the Alumilite* process.

Thus anodically treated, Alcoa Impacts have a harder surface than that which normally forms on aluminum, assuring long-lasting good appearance. The smooth surface on all Alcoa Impacts, regardless of the alloy, takes all these finishes well.

*Trade Name of Aluminum Company of America



Fuse Sleeve—formerly machined from rod or tubing. As an Alcoa Impact, the Ordnance Department saves 40 per cent on raw materials as against machining from rod, 26 per cent as against machining from tube. And, with less metal needed to start, there is less scrap loss resulting in a radical saving in cost.

Alcoa Impacts–

what's in the future?

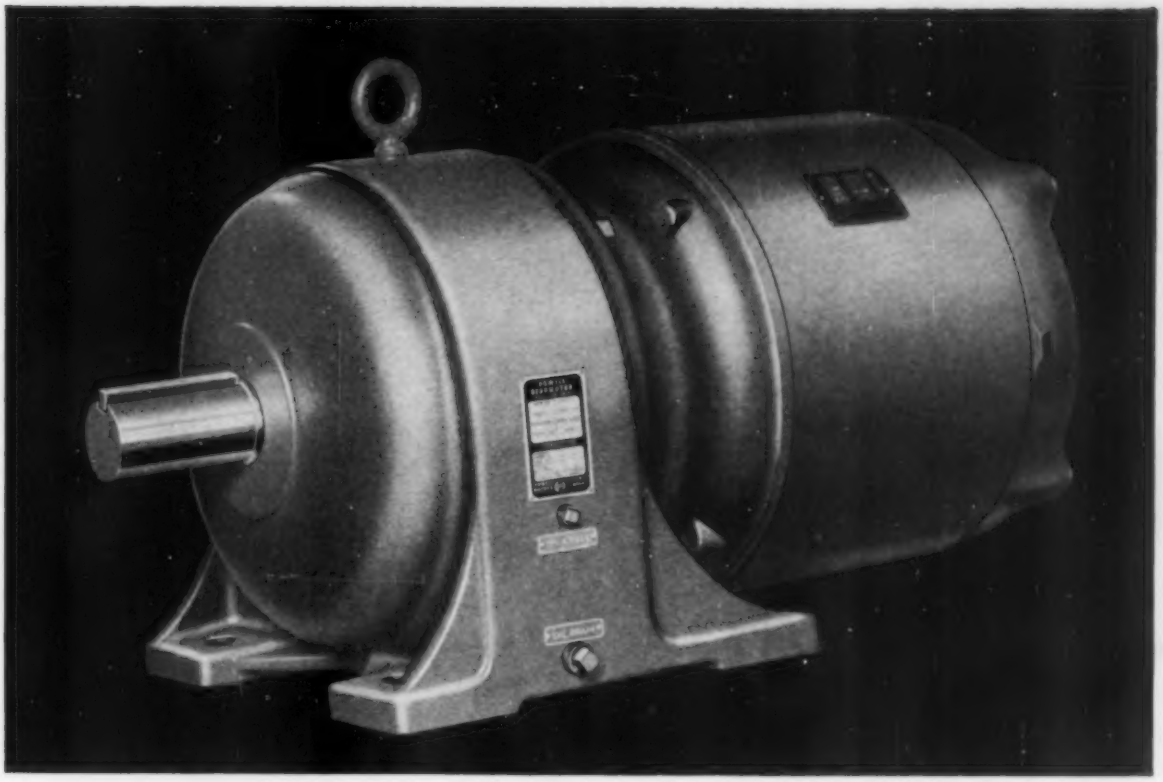
Few fabricating methods in use today can consistently produce shapes with such true dimensional fidelity as fast and at such low cost as impact extrusion. Yet, results from latest tests by Alcoa research engineers hold promise that tolerances and costs will be improved still more. Years of highly successful production experience on parts of high-strength alloys indicate that even greater use will be made of the stronger alloys. As that happens, these stronger parts are sure to become more complex in design, lower in cost.

Already, experimental shapes having a central hub section with arms or spokes of various cross-sectional designs have been produced by a modification of the existing process—lateral extrusion. This technique may well be combined with conventional forward and reverse impact extrusion to produce much more intricate shapes, only dreamed of today.

Your next move ... In this small space, it is virtually impossible to cover all phases of the impact extrusion process or illustrate all the possible uses to which it can be put.

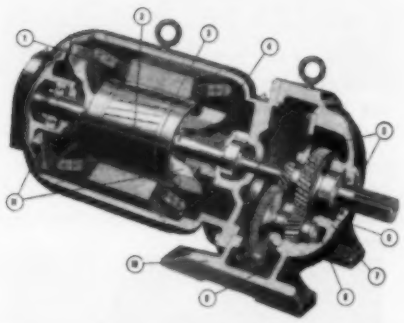
Should you have further questions, write on your company letterhead to ALUMINUM COMPANY OF AMERICA, 1992-F, Alcoa Building, Pittsburgh 19, Pennsylvania, for your copy of the new, *Alcoa Impact Fact Book*.

Better still, contact your local Alcoa sales engineer. His office is listed under "Aluminum" in the classified section of your telephone book. Whether you plan to buy aluminum impact extrusions tomorrow, next week, or a year from now, he'll be glad to discuss your production problem with you. That's his job.



The power you need at the speed you need it . . .

HOWELL GEAR MOTORS



11 reasons why Howell Gear Motors last longer, serve you better

1. High-quality insulation
2. Copper-clad rotor
3. Expert craftsmanship
4. High-quality coil varnish
5. Leakproof oil seals
6. Duti-Rated Lifetime Gearing
7. Unit case construction with integral bearing housings
8. Corner-mounted offset shaft
9. Large oil reservoir
10. Heavy, cast-iron construction
11. Superior cooling

New dependability, greater starting torque and top efficiency, with output speeds as low as 7.5 rpm. are now available in Howell Gear Motors.

This compact, single-unit motor may well be the answer to your gear reduction problems. Combining the finest in heavy duty industrial gearing with the best in motoring, Howell Gear Motors reduce drive failures and production downtime.

Howell Gear Motors use duti-rated, lifetime gearing, with file-hard tooth surfaces and tough, resilient cores. They are available in all types of enclosures, from 7.5 to 780 rpm. with a capacity range from 1 to 30 hp., in all three AGMA service classifications.

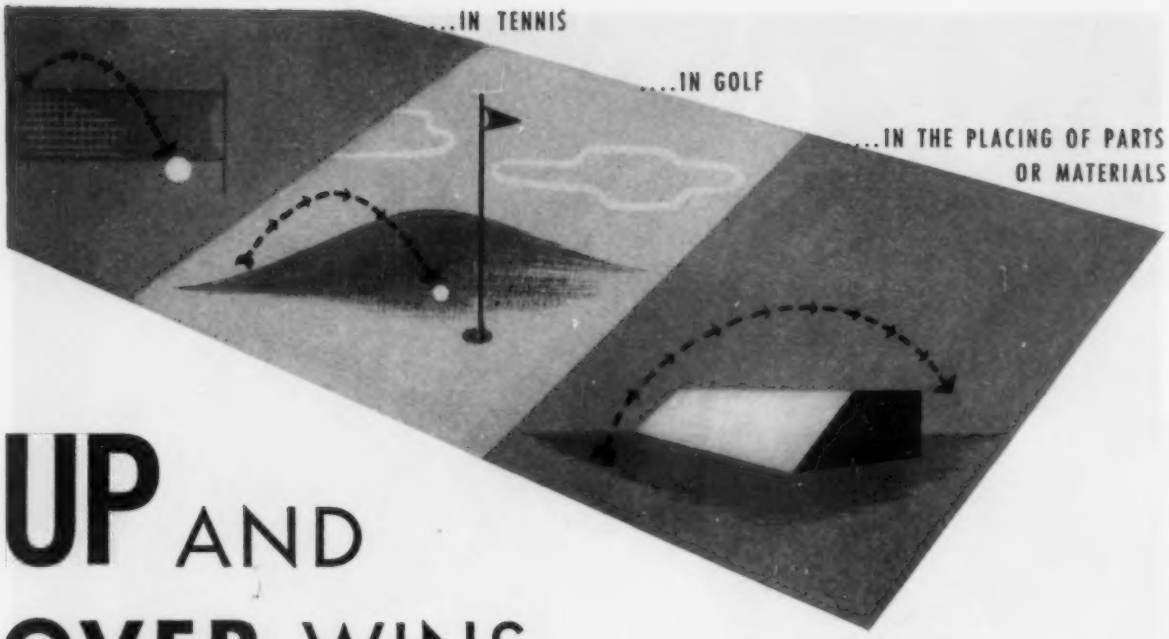
For full information on Howell Gear Motors, contact the Howell man in your area, or write the factory direct for Bulletin GM-1.

HOWELL Red Band MOTORS

HOWELL MOTORS

HOWELL ELECTRIC MOTORS COMPANY, HOWELL, MICHIGAN

MOTORS FOR INDUSTRY SINCE 1915

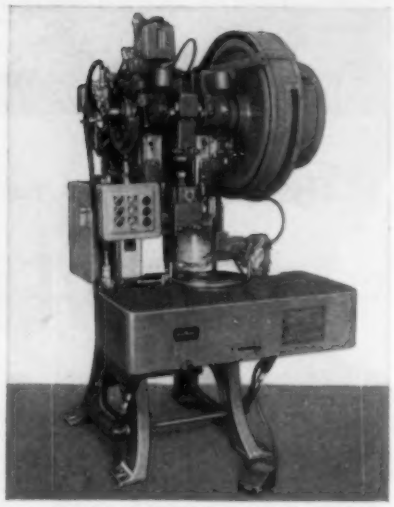


UP AND OVER WINS

Anyone can move parts or materials through single planes and place them in position. Two plane positioning, such as moving a part horizontally and then lowering it vertically, is somewhat more difficult. But three plane positioning, lifting a part up and over an obstruction and placing it with complete precision, needs a V & O Feed-O-Matic.

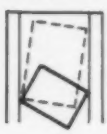
On operation after operation personnel safety can be enhanced, production speeds increased and quality control extended, by using V & O Feed-O-Matics to lift parts up and over the obstacles to precision placement. High cost tools can be used with less fear of breakage. Production delaying stop motions can be eliminated while production itself is increased.

Three plane precision positioning is practical. You can design to use it. Write us and find out how and why.



The Feed-O-Matic is simple and self contained, well enclosed, but highly accessible for servicing.

WHY THE V & O LONG SLIDE PROVIDES BETTER ALIGNMENT



With the same running clearance, the longer the slide the less the possibility for angular misalignment. And we keep our running clearances very close indeed.

Human hands merely feed the parts. Mechanical motions take them up, over, and down into precise positions.

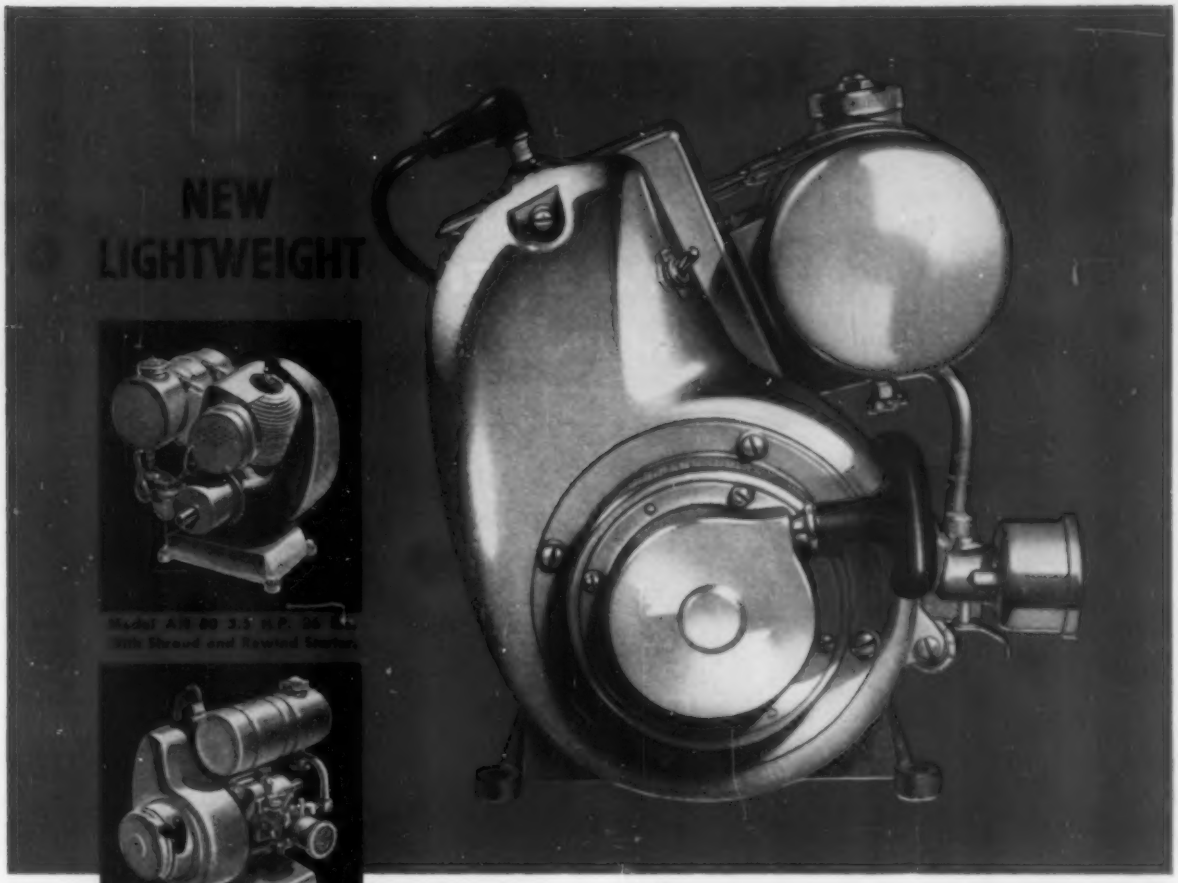
THE V&O PRESS COMPANY

DIVISION OF EMHART MFG. CO.

HUDSON, NEW YORK

BUILDERS OF PRECISION POWER PRESSES AND FEEDS SINCE 1889

65th Anniversary



Model AH47 — 2 H.P. 17 lbs.
With Shroud and Rewind Starter.

POWER PRODUCTS ANNOUNCES

a new line of industrial engines

THERE is no other industrial engine on the market today comparable to this new Power Products engine. It is lighter in weight—more compact in design — requires less effort to start — is simpler to service than any other industrial engine. The design of this engine is the result of adapting to the industrial field many of the principles incorporated in the nationally known Power Products lawn mower and chain saw engines.

These famous engines were used on over 50% of all small rotary lawn mowers in 1953 and by every major chain saw manufacturer who purchased engines. The features these engines offered — lightweight and easy starting for lawn mowers — sustained performance at high speeds and heavy loads for chain saws— are combined in the new industrial engine.

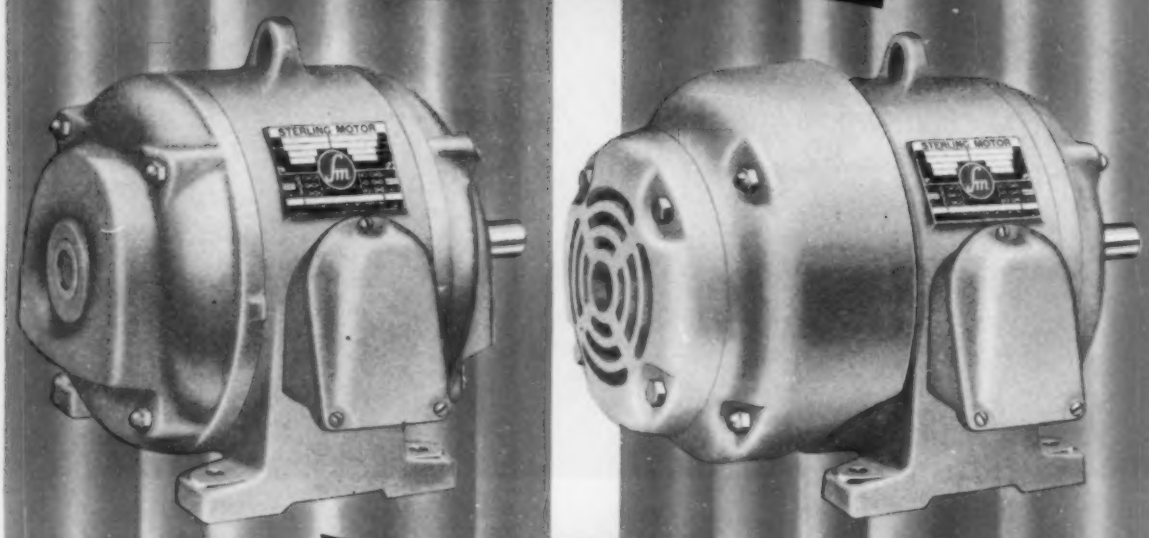
If you make or use any industrial product that requires power in the range of 2 to 4 horsepower, it will pay you to investigate this engine. It can add important advantages to your product. Write today for complete specifications.

POWER PRODUCTS CORPORATION

2013 N. 12th STREET, GRAFTON, WISCONSIN

MORE HORSEPOWER... IN LESS SPACE...

with the **NEW STERLING** *Motor Line*



KLOSD DRIP-PROOF
CONSTANT NORMAL SPEED MOTORS

NEW NEMA MOUNTING DIMENSIONS

KLOSD-TITE FAN-COOLED
CONSTANT NORMAL SPEED MOTORS

PLUS...

THESE 10 STERLING ADVANCED DESIGN FEATURES

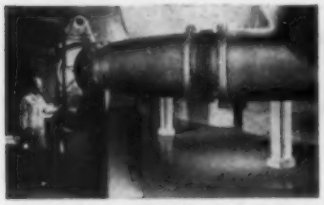
- Over 50% less inactive space
- Protected construction
- Greater bearing protection
- Advanced design terminal box
- Heavy duty ball bearings
- Herringbone rotor
- Direct-through ventilation
- Increased efficiency and performance
- Stator windings of advanced design
- Improved insulation

WRITE FOR NEW BULLETIN NO. F-431-A

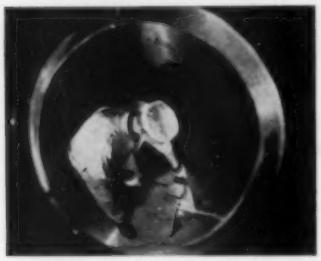
STERLING ELECTRIC MOTORS

New York City 51; Chicago 35; Los Angeles 22; Hamilton, Ont., Canada; Santiago, Chile

HEAT RESISTANCE: ENDURO can handle gases from full scale thermal jet engines, reciprocating engines, turbines, burners and other equipment tested in simulated high altitude conditions.



CORROSION-RESISTANCE: This is one of ENDURO's best known qualities. Installations of various types over the past thirty years offer visible proof that ENDURO stands up under some of the toughest corrosive conditions.



CLEANABILITY: ENDURO's high resistance to radioactive matter makes it a choice for equipment where this material is used. The answer is its smooth finish which offers little surface to which particles can cling.

Here's how they're using some of Enduro's properties

Aviation design engineers have long used ENDURO Stainless Steel for its high strength-to-weight ratio. Its resistance to high as well as sub-zero temperatures.

Now, designers in other fields are discovering new uses for ENDURO. For its remarkable ease of cleaning. For its satin luster. For its high resistance to rust and corrosion.

Management likes ENDURO, too. It can be fabricated profitably. And it gives extra sales features to products which might otherwise be lost in the shuffle.

No other commercial metal offers such a unique combination of physical and chemical properties as ENDURO Stainless Steel, the metal of 10,000 uses. Republic will be glad to help you use it... profitably. Write to:

REPUBLIC STEEL CORPORATION
Alloy Steel Division • *Massillon, Ohio*
GENERAL OFFICES • **CLEVELAND 1, OHIO**
Export Department: Chrysler Building, New York 17, N. Y.

FREE

This 36-page booklet gives properties, fabricating and joining methods, care and finishing of ENDURO Stainless Steels. Write for it. Ask for ADV. 561.

REPUBLIC
ENDURO STAINLESS STEEL

Other Republic Products include Carbon and Alloy Steels — Titanium — Pipe, Sheets, Strip, Bars, Wire, Pig Iron, Bolts and Nuts, Tubing

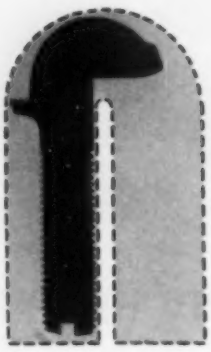
Eight operations cut to four

The old way:

The stud shown here was used by a tank manufacturer to blind feed into a tubing hole during assembly. Multiple diameters were required to hold the stud tight after insertion. To achieve this rather intricate shape, eight operations were originally required . . . until National was asked to study the problem.

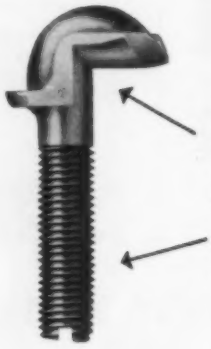
The National way:

Our "Special Products Service" showed this manufacturer how the stud could be produced to specifications *in only four operations* by cold-heading. Because National had the wide range of cold-heading equipment and specialized know-how needed to do the job, production costs were cut 50% . . . and substantial material savings resulted because cold-heading leaves a minimum of scrap.



OLD WAY

Bar stock bent in U-shape was machined to specifications in eight operations, with considerable waste of metal.



THE NATIONAL WAY

Head was upset into shape needed with multiple diameters.

Only four operations needed to complete stud by cold-heading and roll threading.

Bring your "Special" problems to National

Can we help you realize the same type of economy on *your* special fastener needs? Our "Special Products" representative will be glad to study your specifications. Write for free copy of National's "Special" fastener booklet.

Representatives in:
Chicago, Cincinnati, Detroit, New York, Philadelphia, Kansas City, Milwaukee, Rochester, Denver, St. Louis, San Francisco and Seattle.

THE NATIONAL SCREW & MFG. COMPANY
Cleveland 4, Ohio

Pacific Coast: **National Screw & Mfg. Co. of Cal.**
3423 South Garfield Ave., Los Angeles 22, Cal.

National PRODUCTS

Fasteners **Hodell Chains** **Chester Hoists**

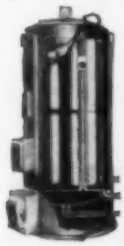
HONAN-CRANE

offers you the finest

OIL AND COOLANT FILTERS • WATER-OIL SEPARATORS
AUTOMATIC CONVEYORS

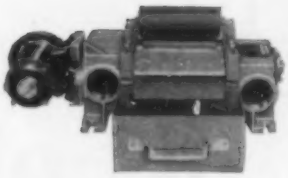
for original or accessory equipment on Hydraulic Units, Engines, Machine Tools, Vacuum Pumps, etc.

OIL FILTERS AND PURIFIERS



Available in many types and sizes to provide needed range in capacity. Use bulk refills or cartridges. Remove all types of contamination.

COOLANT FILTERS



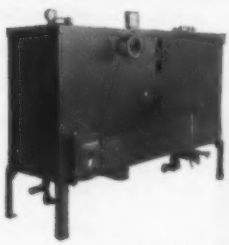
Magnetic Type—New magnetic separator is small, compact and powerful. Ideal for installation on individual machine tools of all types.

Mechanical Type—"T" Type Clarifier removes solid contaminants from oils and coolants. Designed for installation directly in the oil system to use pressure of machine tool sump.

AUTOMATIC CONVEYORS

Collect, transport and discharge all types of solid or fibrous materials which settle to bottom of tanks or hoppers. System eliminates manual handling methods, requires little maintenance.

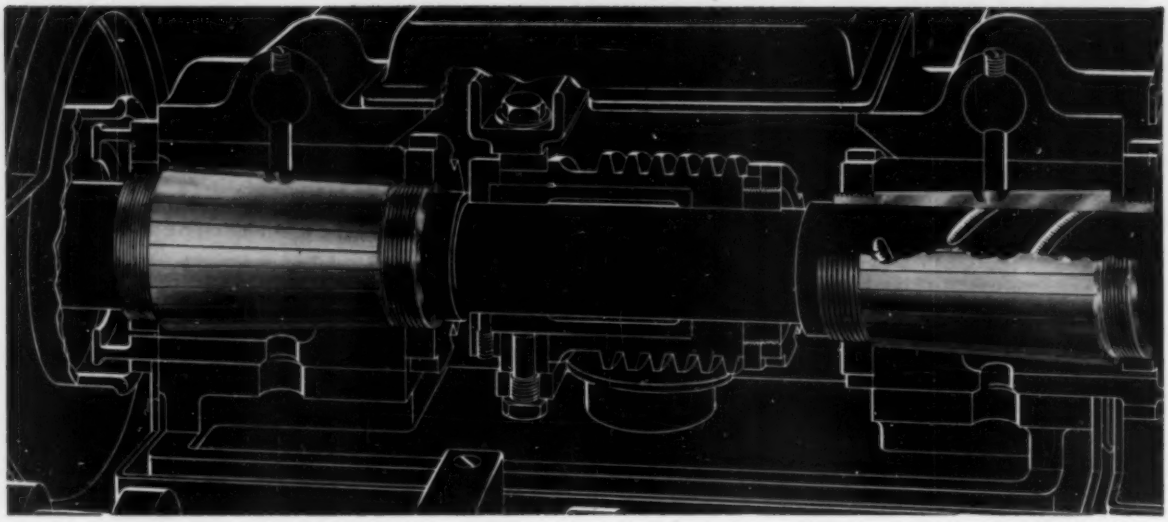
WATER-OIL SEPARATORS



For removal of water from turbine, hydraulic and vacuum pump oils. Easy-to-install DRI-PURE filters out contaminants while removing water. Eliminates changing or discarding of oil.

A filter problem? Conveyor problem? Write today to Honan-Crane for sound, intelligent help backed by more than 30 years' experience in the industrial filter field. Honan-Crane manufactures a full line of equipment that can be adapted to your specific problems. Sales engineers in principal cities.

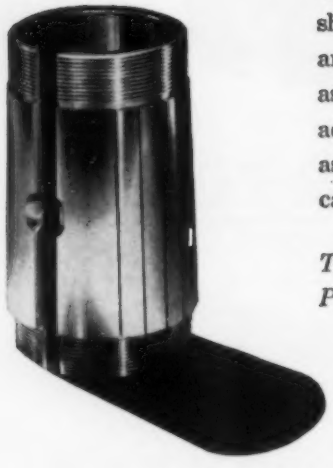
Honan-Crane Corporation
26 Madison Avenue, Lebanon, Indiana
a subsidiary of **Houdaille-Hershey Corp.**



THE WAY TO CUT...

Cost of assembly

The assembly of a unit equipped with sleeve bearings is the simplest, easiest, most understandable assembly possible. After the sleeve bearing has been assembled in the housing or other part that supports it, the shaft which is to operate in it is simply inserted in the bore of the bearing. There is no inboard end cover to assemble on the shaft first, no bearing to be pressed against a shaft shoulder, no lock nut or lock washer to lock the bearing to the shaft, and finally no outside end cover or enclosure to add before the assembly is complete. Not only do these additional parts cost additional money but their preparation for assembly and the actual assembly add serious cost which you can eliminate by using a good cast bronze sleeve bearing design.



There is a Bunting Engineer near you. Consult him. Or write our Product Engineering Department at Toledo.

Bunting®

BRONZE BEARINGS • BUSHINGS • PRECISION BRONZE BARS

The Bunting Brass & Bronze Company • Toledo 1, Ohio • Branches in Principal Cities • Distributors Everywhere

preferred . . .
where top performance is essential

Doelcam

Master-precision Synchros

OUNCE for ounce and inch for inch DOELCAM *Master-precision* Synchros are today's ultimate in accuracy and reliability for electrically transmitting angular position information to remote locations. All performance criteria are guaranteed to equal or surpass the stringent requirements of the latest Military specifications. For applications requiring highest performance such as use in servomechanisms, computers, automatic pilots, airborne radar, etc., DOELCAM *Master-precision* Synchros are proven components. Many thousands in sizes 11 through 31 have been delivered under Prime Government Contracts. Now, the added facilities of our new plant enable us to make these *Master-precision* units available *wherever top performance is essential.* Your inquiry is invited.

Write for Bulletin 53

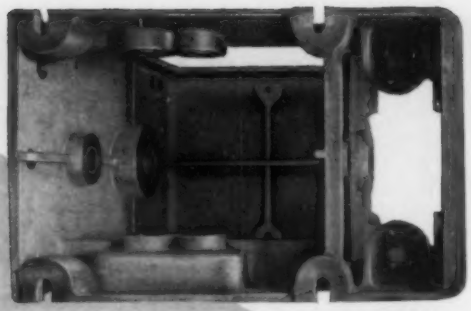
Doelcam CORPORATION

SOLDIERS FIELD ROAD, BOSTON 35, MASS.
West Coast Office: 304 Tejon Pl., Palos Verdes, Calif.

Instruments for Measurement and Control

Synchros • Gyros • Servos • Microsyns • Servo Motors

END



BOTTOM

Figured from any angle...

SIDE

. . . this GRAY IRON casting does a better job for 50% less!

Production of a fabricated steel base for a press formerly cost the manufacturer approximately $302.00 for material and labor. By redesigning this base as a Gray Iron casting, the material and labor costs were reduced to approximately $150.00 . . . *a 50% saving!* Reduced machining time saved another 15%.

In addition to these substantial cash savings, the manufacturer also reports that this Gray Iron casting has proved to be a better all-around design than the fabricated steel base . . . both in appearance and in performance.

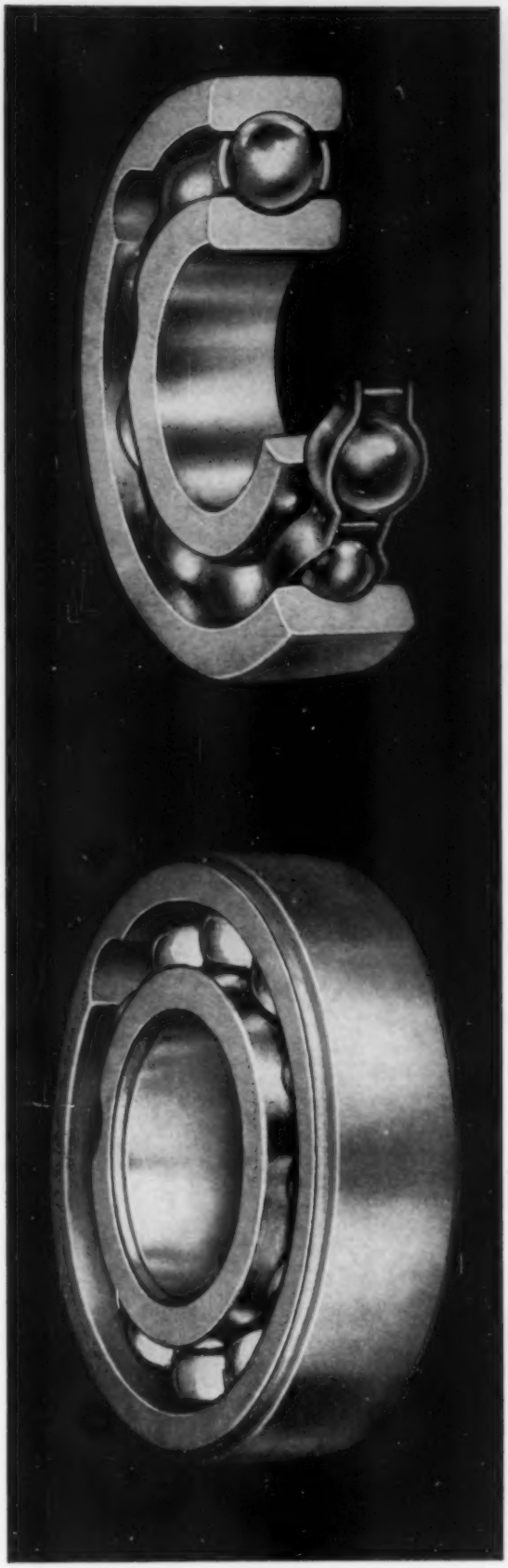
You, too, will find that it pays to use Gray Iron . . . from both engineering and economy angles. We will be glad to furnish you technical information on the many advantages of the Gray Iron casting process.

MAKE IT *BETTER* WITH GRAY IRON

75% of all cast metal products are Gray Iron

GRAY IRON FOUNDERS' SOCIETY, INC.

NATIONAL CITY-E. 6th BLDG., CLEVELAND 14, OHIO



For HEAVY loads specify BCA 1200 and 1300 Series Bearings

These BCA maximum capacity type bearings meet the heavy duty requirements of service in farm tractors, road machinery, power shovels and earth-moving equipment, special materials-handling vehicles.

Maximum capacity type bearings differ from the Conrad type in that additional balls are introduced between the raceways thus increasing radial load carrying capacity to a maximum.

BCA 1200 and 1300 Series Bearings are made to the same standard metric boundary dimensions as corresponding BCA Conrad type bearings.

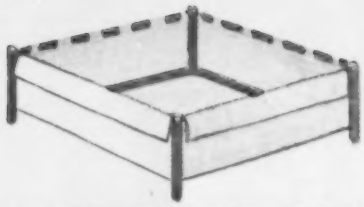
Complete data on these bearings is included among the valuable information in the BCA Engineering Handbook, which is available to chief engineers without charge. Write on your official stationery.

BEARINGS COMPANY OF AMERICA
DIVISION OF FEDERAL-MOGUL CORP.
LANCASTER • PENNSYLVANIA

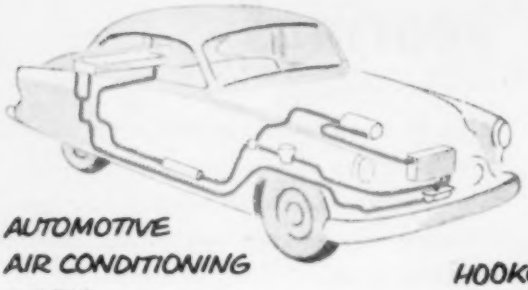
BCA

RADIAL, THRUST, ANGULAR-CONTACT BALL BEARINGS

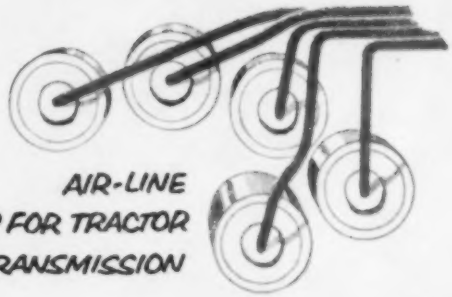
FROM *the Bundy Sketchbook*
TO *jog a designer's imagination*



FRAME FOR DOG-AND-CAT BED



AUTOMOTIVE AIR CONDITIONING LINES

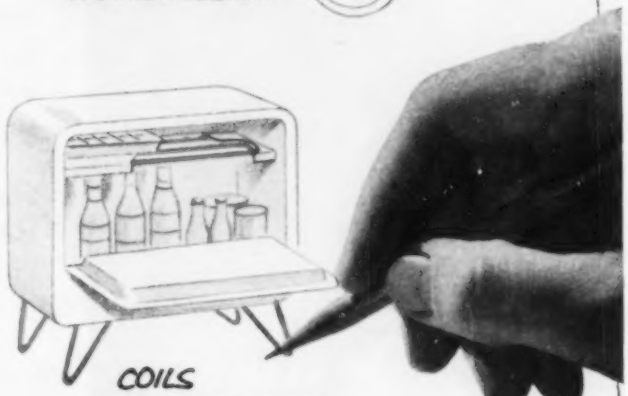


AIR-LINE HOOKUP FOR TRACTOR TRANSMISSION

REMARKS Maybe you demand tubing versatility above all else. Or maybe durability is more important to your product. Whatever your fabrication or performance requirements, you can rely on Bundyweld, the only tubing double-walled from a single strip. Added bonus: Bundy's expert engineering services, unexcelled fabrication facilities.

WRITE today for information or for help in developing your tubing ideas.

BUNDY TUBING COMPANY
DETROIT 14, MICHIGAN



COILS FOR PORTABLE REFRIGERATORS

WHY BUNDYWELD IS BETTER TUBING

Bundyweld starts as a single strip of copper-coated steel. Then it's . . .

continuously rolled twice around laterally into a tube of uniform thickness,

and passed through a furnace. Copper coating fuses with steel. Result . . .

Bundyweld, double-walled and brazed through 360° of wall contact.

BUNDYWELD TUBING®

DOUBLE-WALLED FROM A SINGLE STRIP

Leakproof
High thermal conductivity
High bursting point
High endurance limit
Extra-strong
Shock-resistant
Ductile
Lightweight
Machines easily
Takes plastic coating
Takes plating
Bright and clean
No inside bead
Uniform I.D., O.D.

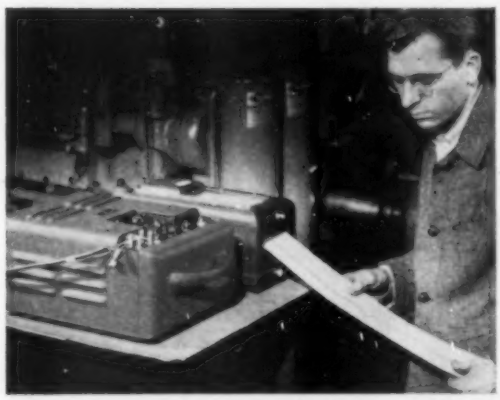
Bundy Tubing Distributors and Representatives: ***Bridgeport, Conn.:*** Korhumel Steel & Aluminum Co., 117 E. Washington St. • ***Cambridge 42, Mass.:*** Austin-Hastings Co., Inc., 226 Binney St. ***Chattanooga 2, Tenn.:*** Pairson-Deakins Co., 823-824 Chattanooga Bank Bldg. • ***Chicago 32, Ill.:*** Lapham-Hickey Co., 3333 W. 47th Place • ***Elizabeth, New Jersey:*** A. B. Murray Co., Inc., Post Office Box 476 • ***Los Angeles 58, Calif.,*** Tubesales, 5400 Alcoa Ave. • ***Philadelphia 3, Penn.:*** Rutan & Co., 1717 Sansom St. • ***San Francisco 10, Calif.:*** Pacific Metals Co., Ltd., 3100 19th St. • ***Seattle 4, Wash.:*** Eagle Metals Co., 4755 First Ave., South • ***Toronto 5, Ontario, Canada:*** Alloy Metal Sales, Ltd., 181 Fleet St., N.

Bundyweld nickel and Monel tubing are sold by distributors of nickel and nickel alloys in principal cities.

Recording strain in boom of power shovel with Brush Universal Amplifier and Dual-Channel Oscillograph.

WHAT DO YOU WANT TO MEASURE?

Brush Portable Instruments will put it in writing . . . immediately



Recording engine torque with Brush Universal Amplifier and Oscillograph.

You can save hours of engineering time and streamline your testing with Brush Recording Instruments . . . which measure and record stress, strain, vibration, pressure, torque, electrical characteristics and many other variables. Chart records, which eliminate laborious plotting, are produced instantaneously. The charts permit quick visual examination and also provide a permanent record of tests.

Brush offers a complete line of amplifiers, oscillographs and "packaged" analyzers for specific measurement jobs. You can record a single channel of data, or up to six channels simultaneously. You have a choice of direct-inking or combination ink and electric-writing oscillographs. Units are all designed for portability and rugged use.

For complete information call your nearby Brush representative, or write Brush Electronics Company, Dept. L-6, 3405 Perkins Avenue, Cleveland 14, Ohio. In Canada: A. C. Wickman, Ltd., Toronto.

BRUSH ELECTRONICS COMPANY

INDUSTRIAL AND RESEARCH INSTRUMENTS
PIEZO-ELECTRIC MATERIALS • ACOUSTIC DEVICES
MAGNETIC RECORDING EQUIPMENT
ULTRASONIC EQUIPMENT

formerly The Brush Development Co. Brush Electronics Company is an operating unit of Clevite Corporation.

Screened

FOR BETTER PERFORMANCE

in your product, too

No part of a precision performance product can ever be of dubious dependability. Automobile, aircraft, and other modern industries demand precise specification materials for all parts, however small. Industrial wire cloth goes into so many vital parts. It can't be just wire cloth. It should be Reynolds Wire Cloth. Precision-processed to the last detail—exactly to your specifications—to meet specifically the requirements of your individual parts, or products, and their uses.

For details see *Sweet's Product Design File*

... or consult Reynolds Engineers.

Reynolds WIRE CLOTH for Industry

NS NATIONAL-STANDARD Company NILES, MICHIGAN

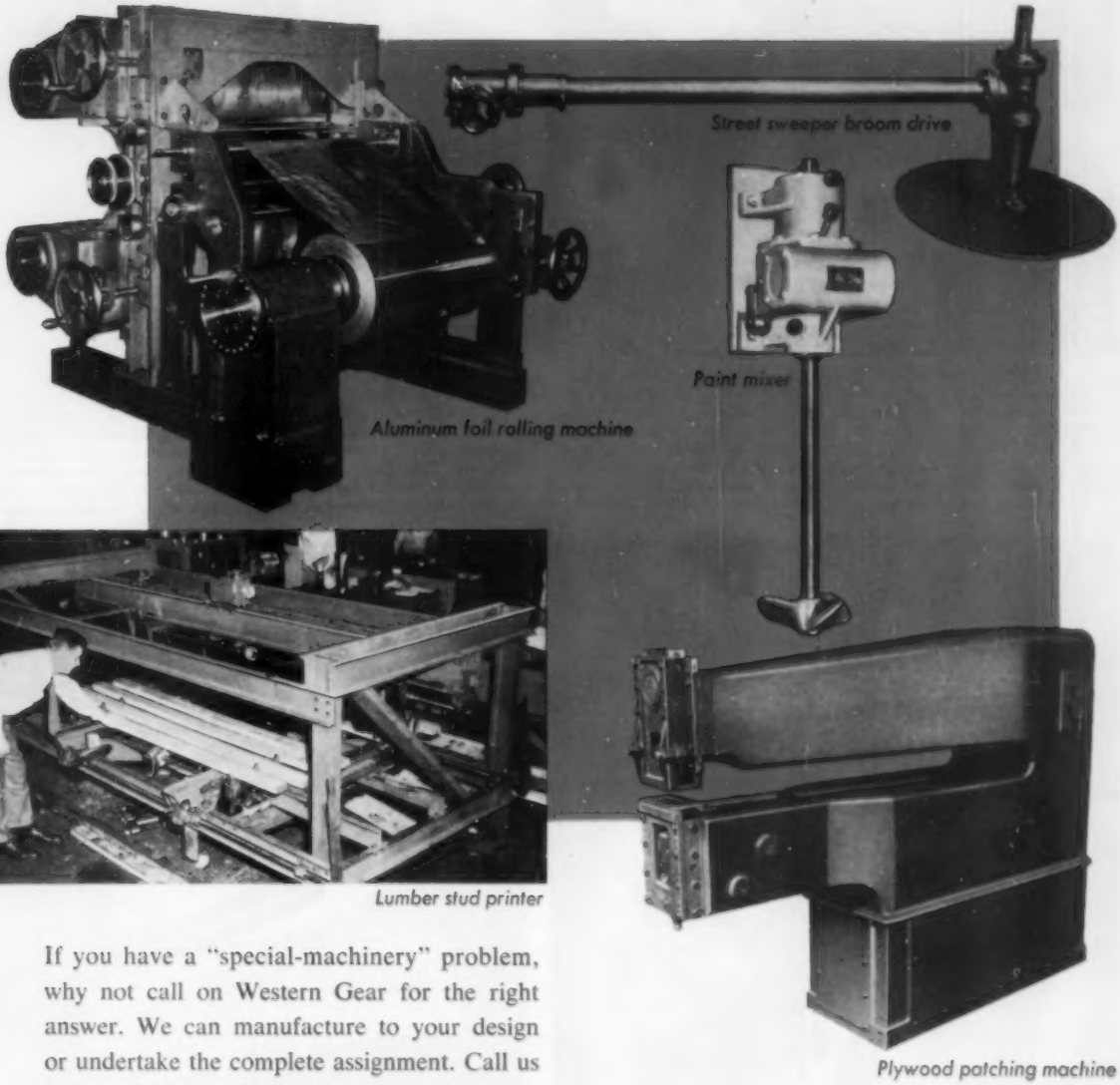
REYNOLDS WIRE DIVISION, NATIONAL-STANDARD CO., Box 200, **DIXON, ILL.**

Divisions of National-Standard Co.

ATHENIA STEEL...*Clifton, N. J.*	Flat, High Carbon, Cold Rolled Spring Steel
NATIONAL-STANDARD...*Niles, Mich.*	Tire Wire, Fabricated Braids and Tape
WAGNER LITHO MACHINERY...*Jersey City, N. J.*	Metal Decorating Equipment
WORCESTER WIRE WORKS...*Worcester, Mass.*	Round and Shaped Steel Wire, Small Sizes

Special Machinery did you say?

that's a WESTERN GEAR *Specialty!*



Lumber stud printer

Plywood patching machine

If you have a "special-machinery" problem, why not call on Western Gear for the right answer. We can manufacture to your design or undertake the complete assignment. Call us now—whether your idea is still in "the talking stage" or ready to proceed. We'll save you time and money.

Illustrations show a variety of machines manufactured by Western Gear. For further information, please write Western Gear Works, Executive Offices, P.O. Box 182, Lynwood, California.

GEARMAKERS, ENGINEERS AND MANUFACTURERS "SINCE 1888"

WESTERN GEAR WORKS

PACIFIC-WESTERN PRODUCTS | POWER TRANSMISSION GEARS • MACHINERY •

PACIFIC GEAR & TOOL WORKS · SOUTH WESTERN GEAR WORKS

5410

PLANTS AT LYNWOOD, PASADENA, BELMONT, SAN FRANCISCO (CALIF.), SEATTLE AND HOUSTON — REPRESENTATIVES IN PRINCIPAL CITIES

How would YOU solve these two problems?

1. A PATCH AHEAD OF TIME, applied at the factory, reinforces the knees of dungarees and overalls. Patches are vulcanized under pressure with Radio Frequency Corp.'s high frequency, dielectric heater. If dielectric heat, generated in the material, is lost through conduction, vulcanization becomes inefficient. But Fenwal THERMOSWITCH® units in each platen minimize these losses by close temperature control. Vulcanizing 3000 patches per hour is now standard; 30 was.

2. DENTAL PLATE FIT STARTS WAY BACK. The tiny abrasive wheels for grinding and polishing dental plates must be very accurately molded of fine abrasive in a rubber base. The molds in which they're made must have delicate temperature control for consistent quality and uniformity. The manufacturer, The Wm. R. Hall & Son Co., uses THERMOSWITCH units in molds for accurate, reliable temperature control. Production figures can be kept high while rejects are low.

3. THIS IS IT — the Fenwal THERMOSWITCH control is simple — compact shell contracts or expands *instantly* with temperature changes, opening or closing electrical contacts. Adjustable and highly resistant to shock and vibration. Fenwal THERMOSWITCH units are solving temperature problems and helping to improve the final product throughout all industry.

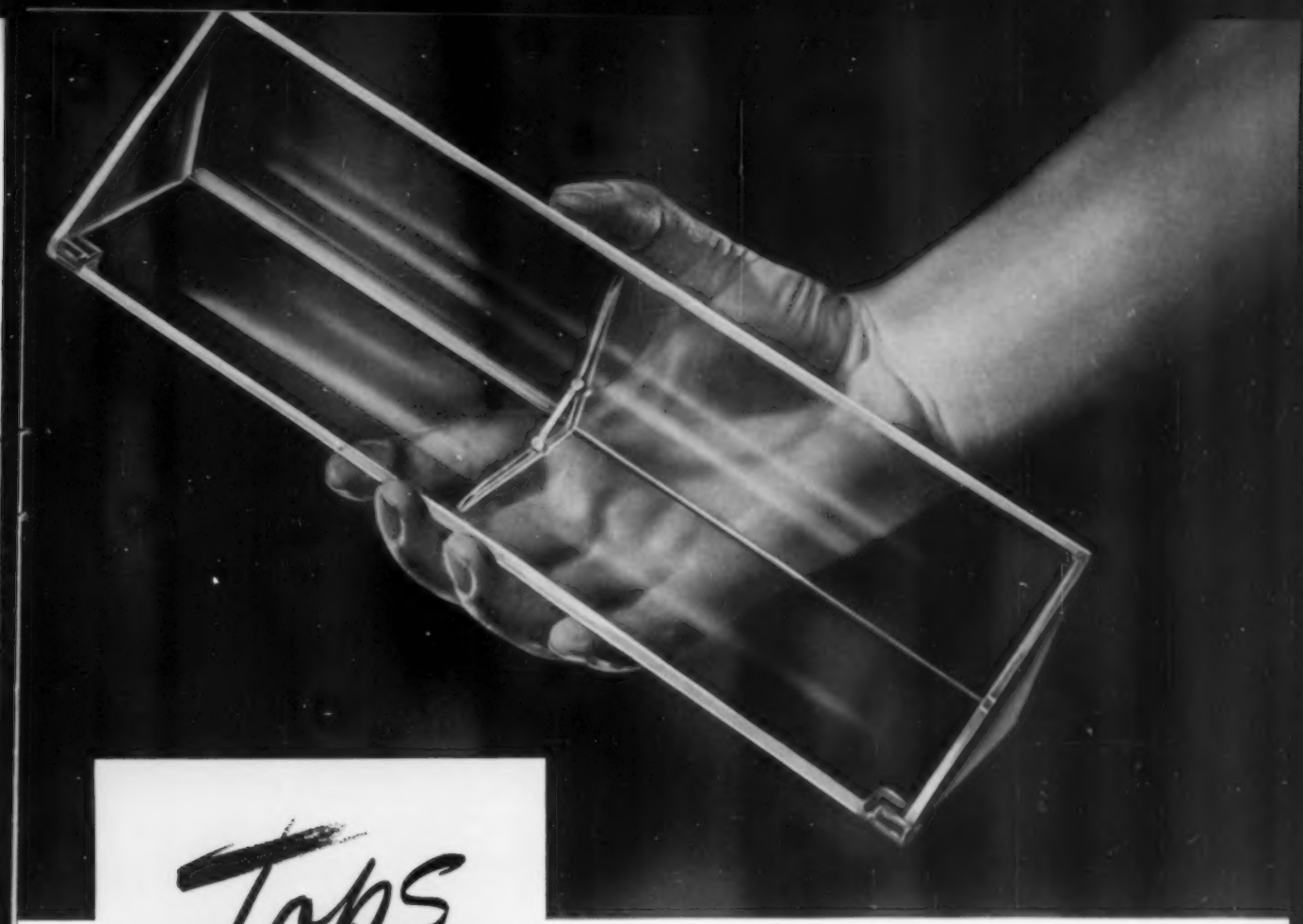
4. SEND FOR THIS BROCHURE for complete explanation of the unique THERMOSWITCH unit. Also ask for more detailed, illustrated discussions of the problems above. Fenwal engineers will be glad to help you solve your temperature control problems involving heat, humidity, radiant heat, pressure and other variables. Write Fenwal Incorporated, 26 Pleasant St., Ashland, Massachusetts.

Fenwal

THERMOSWITCH®

Electric Temperature Control and Detection Devices

SENSITIVE... *but only to heat*



Tops IN PLASTICS

● Often the success story of a plastic part goes like this: The manufacturer first uses it to replace his metal part only because of a threatened shortage of the metal. Then he discovers that the plastic part is actually more practical and satisfactory. The "part-time job" becomes permanent. This gable-type cover for serological baths, for instance, has the advantage over the former metal cover of being transparent as well as resistant to corrosion. The new serological bath equipment is used in laboratories for Wasserman and Kahn tests with blood samples incubated in constant temperatures of 37°C. and 56°C. May we see if we can find a success story in one of your products?

Polystyrene gable molded for Precision Scientific Co., Chicago, builders of laboratory equipment.

Write on your letterhead for our colorful 40-page catalog containing data and illustrations of Injection Molded and Extruded Plastics . . . if you are interested in ~~MILLS PLASTIC~~ *tubing and fittings, write for our new six-page circular.*

CONTINENTAL CAN COMPANY

MILLS PLASTIC DIVISION

INJECTION MOLDERS and EXTRUDERS of Tenite, Lumarith, Plastacele, Fibestos, Lucite, Nylon, Flexiglas, Polystyrene, Styron, Loalin, Vinylite, Geon, Plexene, Polyethylene, Cerex, Fortisol, ~~MILLS PLASTIC~~, Saran, and other Thermoplastic Materials.

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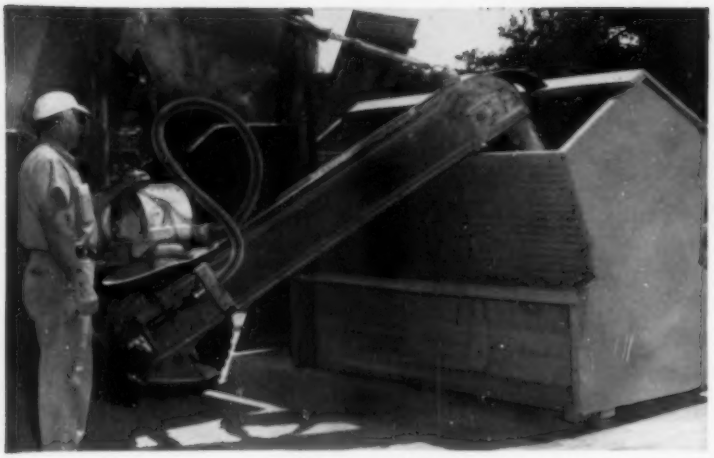

STOW flexible shafting drives this conveyor used to feed ducks. Owned by Mr. Harry Baker of East Port, Long Island.

STOW flexible shafting on the job in AGRICULTURE!

Here are just a few of the many ways STOW Flexible Shafting is being used in agricultural applications. 75 years of experience has given us that all-important know-how you'll find so helpful in working out power transmission and remote control problems on your agricultural equipment.

SHAFTING AVAILABLE IN SIZES 1/8" to 1 5/8"

TRANSMITS UP TO 10 HP at 500 RPM

STANDARD TERMINALS AVAILABLE. special terminals for particular applications

WRITE TODAY FOR FREE AIDS!

Send for FREE Torque Calculator! Gives you the information you need simply, quickly. Eliminates lengthy calculation. Write today, on your company letterhead.

Write today for your free copy of Bulletin 525 containing complete engineering data on STOW flexible shafting.

STOW MANUFACTURING CO.

426 State St., Binghamton, N. Y.

STOW flexible shafting powers this Avery Rake, built by the B. F. Avery Division of Minneapolis Moline Company, Louisville, Ky.

STOW flexible shafting drives the feed conveyor on this G.L.F. bulk feed delivery unit operated by Broome G.L.F. Elevator.

STOW flexible shafting transmits power from the accessory gear box to the pump of the Aero Mist Master, manufactured by Mabry I. Anderson, Mississippi Valley Aircraft Service.

STOW flexible power drive shaft operating telephone pole hole digger. Courtesy of American Telephone and Telegraph Co.

Now Available...

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ENGINEERED FOR PREDETERMINED PERFORMANCE

You specify end use – we deliver Teflon specially formulated for your job and finished to close tolerances. From original Dixon research and experience, we know which Teflon compositions have the characteristics you require. Before going into production, we analyze the conditions of your application – thoroughly work-test the material on our own apparatus. Teflon engineered to your order by Dixon comes to you with *all performance factors predetermined.*

We Supply Teflon Forms As Follows – Extrusions, compression moldings, cross-sectional shapes, very thin spaghetti tubing, hot forgings and fabricated forms of every description – (lengths as long as the carrier, whether freight car or truck), etc.

We Are Teflon Specialists – Producers of pure or filled Teflon compositions, engineered for specific uses—like our own Rulon®, unique new bearing material "slippery throughout, from outer skin to inner core". We regularly do the difficult high quality jobs in close tolerance.

We Give Good Service – Definite assurance of what Teflon can or cannot contribute to your operation, backed with reliable data. Deliveries when due, because we have the basic information and experience to fill your order without fumbling.

We Provide Sample Kits – For designers and engineers thinking creatively about fluorocarbon plastics, we supply at a nominal price kits containing at least a pound of Teflon and Rulon samples in assorted shapes and sizes—indispensable for experimental use.

We Can Advise You – Besides fabricating special shapes to your order, we counsel you on specifications for mechanical, electrical, chemical and many other applications. Just request our Engineering Service to work with you, at no obligation.

Dixon technical data sheets available for your reference library include: "Teflon-Plus", "Friction Abrasion & Hardness of Rulon", "Machining & Fabrication of Teflon and Rulon", "Typical Properties of DL-1 Teflon", "Teflon Pipe Dope", etc. Free on request.

*Teflon is DuPont's trademark for its tetrafluoroethylene resin.

DIXON CORPORATION

Established 1876

Bristol, Rhode Island • Telephone Bristol 1-1780

Write us direct or contact our nearest representative in

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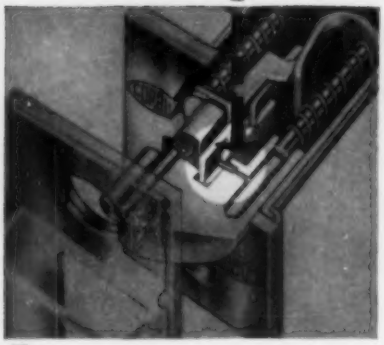
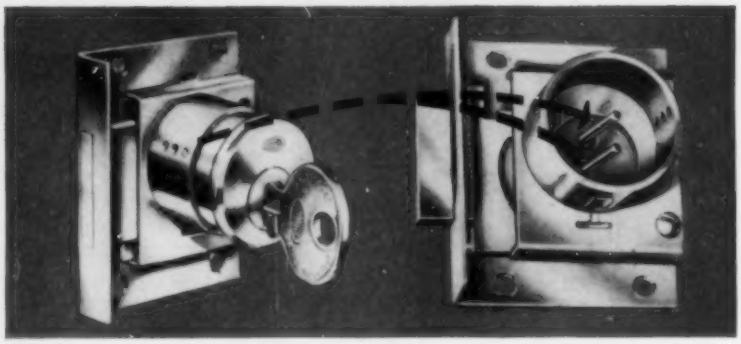
SPIROL PIN's strength and radial tension improve two locks for American Hardware!



1 New Corbin "Defender" lockset has latchbolt designed around hidden Spirol pin fastening. Pin holds in place with only 1/16" engaged at each end. Bolt tail rides on exposed 1/8" center portion of pin. Spirol's radial tension locks pin in place, prevents it riding into track of plunger bolt.



2 Three interchangeable cylinders make the revolutionary new Corbin "Adapta-Lock" adjustable to six different thicknesses of wood or metal. Headed Spirol pins hold any of the cylinder plugs firmly in barrel, yet allow easy adjustment to 3 positions. Spirol pins were substituted for solid pins when tests on models proved that their unique coil construction not only locked them securely into the cam, but also gave them greater shear strength. Even at maximum depth where pins project only 9/32" into cylinder, Spirol pins hold rigid, assure perfect tumbler contacts.

The strength and tension characteristics of Spirol pins, which enabled American Hardware engineers to improve the design and performance of these locks, are only two of the many qualities that recommend Spirol pins to engineers. Controllable tension and shear strength allow these pins to meet a wide range of specifications. Since reaming and riveting operations are eliminated, the pins reduce cost, speed production. Standard Spirol pins are made from heat-treated strip steel in sizes ranging from 1/32" to 1/2" diameters, 1/8" to 4" lengths. Special materials and sizes available to your specifications. *Write for literature and free sample Spirol pins.*

When compressed by insertion, Spirol pins exert even radial pressure, develop no weak "hinge" lines. "Live" action keeps pins locked tightly in hole, makes them dependable in fastening fragile plastic or heavy metal parts.

SPIROL PIN

U. S. and Foreign Patents Pending

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STEEL PLATE SHAPES
Directly from Blueprints to Close Tolerances
Ready for Quick Finishing or Assembly
Get Maximum Return on Capital Investment and Plate Inventories
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PLATE THAT'S SHAPED TO SAVE YOU MONEY

YOU SAVE both time and money using this new Steel Plate Shapes Service. Find out how you can start production several steps ahead. You can eliminate plate inventories, and you pay freight only on that part of the plate that is actually required.

There's no need to invest in new cutting and forming equipment for your own shops. We have over 150 major machines to flame-cut, shear, blank, press, bend or otherwise form steel plate.

This new Bulletin 712 shows how Steel Plate Shapes Service can help you. For a free copy, use this coupon or write on your company letterhead.

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Bars, sheets, wire, pipe and tubing now available through your Chase warehouse or sales office.

So many Chase customers use stainless steel in addition to brass and copper that we have added this metal to our regular line.

Now you can get the same top-notch Chase Service on Stainless Steel that you've been used to on other Chase products. Of course, regular delivery and cutting facilities are available on Stainless Steel orders, too.

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All 24 Chase warehouses plus the Chase sales offices and Chase mills are ready to help you get prompt delivery. If your Stainless Steel order can't be filled from local stock, you'll get prompt shipment from another of the Chase warehouses or from the mill.

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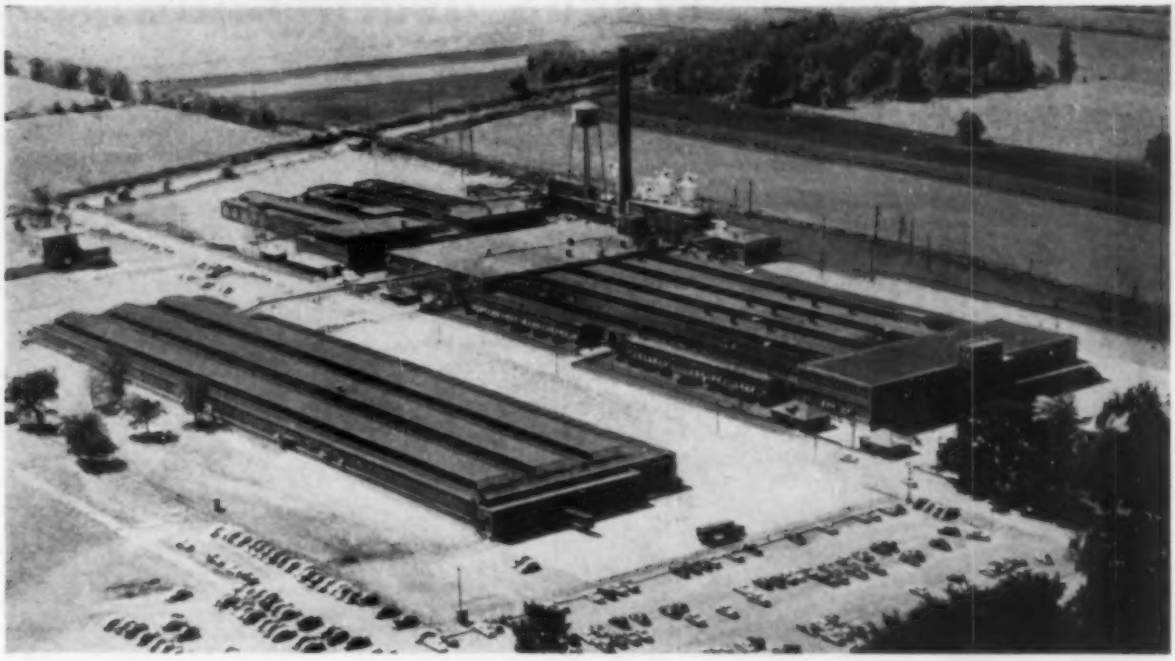
YOU NAME IT-WE'LL MAKE IT



BIRTHPLACE OF BETTER PRODUCTS: The Goodyear plant at St. Marys, Ohio — equipped the men and machines to mass-produce molded and extruded goods of rubber or plastic — on "spec" and on time.

FOLKS often ask us what we make. The answer is: *You* tell *us* — ours is a factory with an unforeseeable future. The biggest part of our business in our St. Marys, Ohio plant is making molded and extruded rubber or plastic goods to customer specifications.

We just don't know today what new products we'll be turning out tomorrow. We don't know what's going on in the minds of designers and engineers who recognize the advantages of properly compounded rubber. We don't know who'll be knocking on our door with another tough problem.

But this we do know! Ours is the largest, most modern plant of its kind. We have over a half million square feet devoted exclusively to the mass production of molded and extruded parts. We have our own metal preparation and plating shop. We have lines of extruders. We have over 350 presses including the latest transfer and full injection types. And we have a top-notch staff of designers and compounders who are experts at getting the most out of rubber to solve problems you may submit.

Boastful? No, just confident. We've seen the smiles on our customers' faces. We know, if anyone can help you, we can — and on schedule, too. Why not try us? Just write to Goodyear, Industrial Products Division, St. Marys, Ohio or Akron 16, Ohio.

GOODYEAR

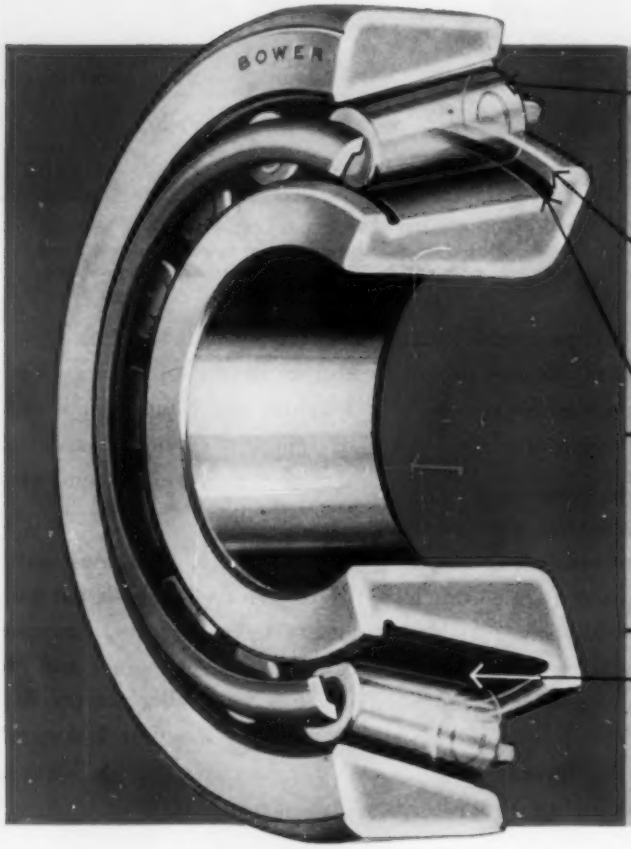
THE GREATEST NAME IN RUBBER

We think you'll like THE GOODYEAR TELEVISION PLAYHOUSE—every other Sunday—NBC TV Network

Here's how BOWER Spher-o-honed design lengthens bearing life... cuts maintenance costs!

The Bower tapered roller bearing design features shown on this page are vitally important to every bearing user. For they illustrate the high quality, precision workmanship and close attention to engineering detail that go into *every* Bower bearing. Even more important, these Bower design features will give you significant bearing advantages such as reduced wear, longer bearing life and lower maintenance requirements. They've been thoroughly *proved* by extensive use in virtually every type of bearing application. If your product uses bearings—whatever it may be—specify Bower now. Or better yet, call in a Bower engineer while your product is still in the blueprint stage.

BOWER ROLLER BEARING COMPANY • DETROIT 14, MICHIGAN



● **SPHERICAL ROLLER HEADS ARE GENERATED TO THE CONTOUR THEY ACQUIRE IN THE COURSE OF WEAR.** This helps Bower bearings hold adjustment and pre-load longer and better. Normal running-in time is virtually eliminated.

● **HIGHER FLANGE PROVIDES A LARGE, TWO-ZONE CONTACT FOR ROLLER HEADS,** thereby reducing unit pressure. This exclusive Bower feature improves roller alignment, greatly reduces wear and practically eliminates resultant "end play."

● **LARGER OIL GROOVE GIVES POSITIVE LUBRICATION** at the critical point—where the roller head thrusts itself against the cone flange. Here Bower design provides a larger recess that holds a generous supply of lubricant—increasing efficiency and decreasing wear.

● **PRECISION RACES PROVIDE QUIETER, SMOOTHER OPERATION.** A Bower-developed grinding and honing process provides a micro-smooth surface of hard, crystalline base metal. In this way, close-tolerance precision is built-in to stay! No final adjustment is needed!

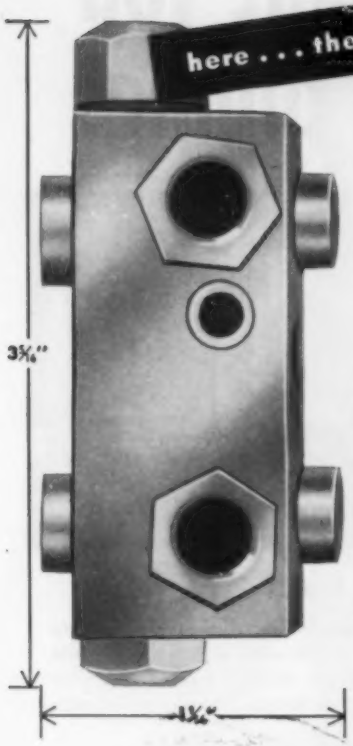
A COMPLETE LINE OF TAPERED, STRAIGHT AND JOURNAL ROLLER BEARINGS FOR EVERY FIELD OF TRANSPORTATION AND INDUSTRY

BOWER

ROLLER BEARINGS

SPHER-O-HONED

here . . . the "lubrication fitting" that never forgets!



ALEMITE Accumeter®

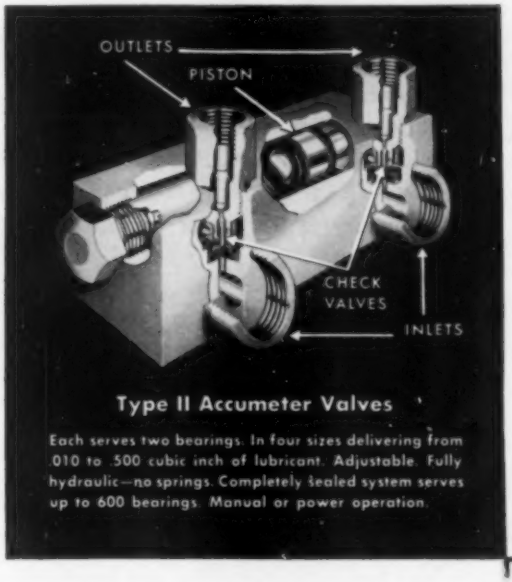
provides automatic, fool-proof lubrication for the heaviest, biggest machines, operating under the toughest conditions . . . indoors or outdoors!

Picture a machine under the toughest job conditions you can imagine. Where bearings operate under the *worst* conditions—in dust, rain, fumes, grit—even completely immersed. Here, ordinary manual lubrication methods would be costly—man-hours would be wasted and production time lost while the machine was shut down for lubrication.

If you were designing this machine, what method could you specify to make sure *every* bearing would always be properly lubricated?

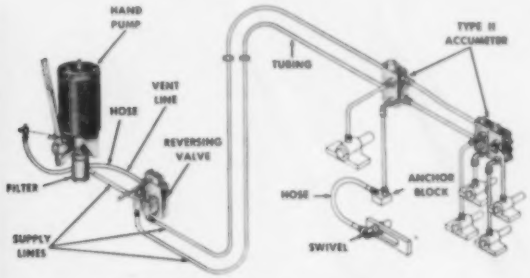
Here's the answer—Alemite Accumeter, the valve that is far more dependable than any man. This simple, completely sealed system delivers an *exact* amount of lubricant where it is needed at *exactly* the right time—*while the machine is in operation!* Time, maintenance and production costs drop—while output soars! No wonder more than 95% of all major plants buying machine tools specify centralized lubrication!

And Alemite Accumeter Systems are easy to design into any machine—and there is a system ready to solve any machine lubrication problem. Find out about these automatic systems now. See for yourself the tremendous savings and efficiency they allow you to offer when you specify automatic Accumeter.



Type II Accumeter Valves

Each serves two bearings. In four sizes delivering from .010 to .500 cubic inch of lubricant. Adjustable. Fully hydraulic—no springs. Completely sealed system serves up to 600 bearings. Manual or power operation.



offers all these advantages!

- Eliminates shut-down time for lubrication. Adds productive time to machine output.
- Seals completely against dirt, grit, fumes, water all the way from "barrel to bearing."
- Prevents bearing troubles due to neglect or wrong lubricant.
- Services all bearings—including those inaccessible or dangerous—in one operation.
- Avoids work spoilage and bearing repairs due to over-lubrication.

factory tested—field proved

Exhaustive, in-the-field tests show no appreciable variation in the amount of lubricant discharged after 73,312 lubrication cycles. Equal to 122 years of twice-a-day service!

Free—*Alemite Accumeter Catalogue*

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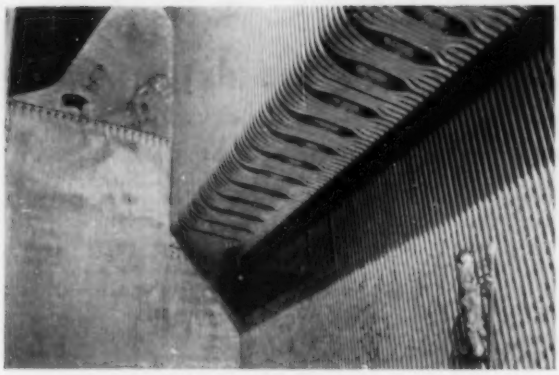
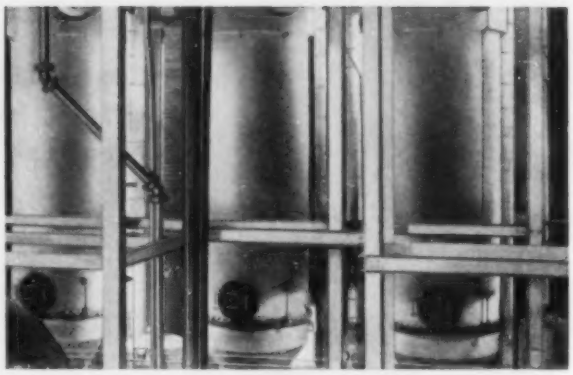
A PRODUCT OF SW STEWART-WARNER

There's no limit to what you can do with the right tubing!



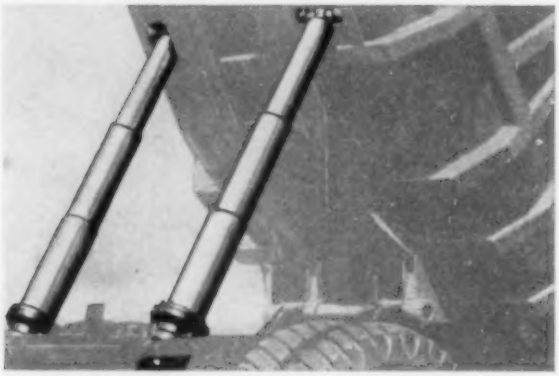
make power to light a city . . .

There are more than 12 miles of Globe seamless pressure tubing (carbon, alloy, and stainless) in this modern boiler which is a vital part of the electric power plant that serves a large metropolitan community.



transfer corrosive liquids . . .

Black liquor, used in production of kraft papers, is highly corrosive and has to be carried under pressure in multiple effect evaporators. Gloweld (electric welded) Stainless Steel Tubing was found to do the job best—at lowest cost.



or lift a load of dirt . . .

Mounted on a dump truck, these twin hydraulic hoists are built to handle heavy loads. Design and production is simplified by making the telescoping arms of Globe mechanical tubing.

THERE are probably a thousand and one different tube applications that could be made in your own products or industry. Check the possibilities. Globe engineers will be pleased to give helpful advice on how the right tubing — Globe tubing — can help you save time, save money, save manpower. Write for literature on any of these products.

GLOBE STEEL TUBES

GLOBE STEEL TUBES CO.
MILWAUKEE 46, WISCONSIN

Field Offices: Chicago • Cleveland • Detroit • New York
Philadelphia • St. Louis • Denver • Houston
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A quick check list of GLOBE STEEL TUBES

ALLOY STEEL: to meet heat, corrosion, pressure, and structural strength problems. Carbon Moly, Chrome Moly Nickel and others. Sizes: O.D. from ⅛ to 6 inches. Wall thickness .035 to 1.000 inch.

CARBON STEEL: for load bearing structural members with strength, least weight . . . for fast, low-cost manufacturing of machine parts or pressure tubing applications. Low and medium carbon. Sizes: O.D. ½ to 7½ inches. Wall thickness: .028 to 1.000 inch.

STAINLESS SEAMLESS: in sizes from ½ inch to 6 inches O.D., and in pipe sizes ⅛ inch to 6 inches, standard, extra strong and double extra strong weights.

STAINLESS WELDED: Gloweld electric welded stainless steel tubing offers many economies. Sizes: O.D. ¼ to 5 inches. In standard wt. pipe sizes ⅛ to 2 inches. In lightweight pipe sizes ⅛ to 4½ inches inclusive.

HIGH PURITY IRON: Globeiron tubing is 99.5% pure ingot iron. For applications where ductility, toughness, easy weldability and easy forming are desired or for use where magnetic permeability and electrical properties are required.

SPECIAL ANALYSES: Globe Steel Tubes Co. regularly produces tubing to special customer specifications. Consult with Globe's representatives for analyses to suit your needs.

GLOBE WELDING FITTINGS: seamless, carbon and stainless, available in a complete line of sizes and weights through Globe distributors in key cities.

Construction Machinery

Assembly Conveyors

Drilling Equipment

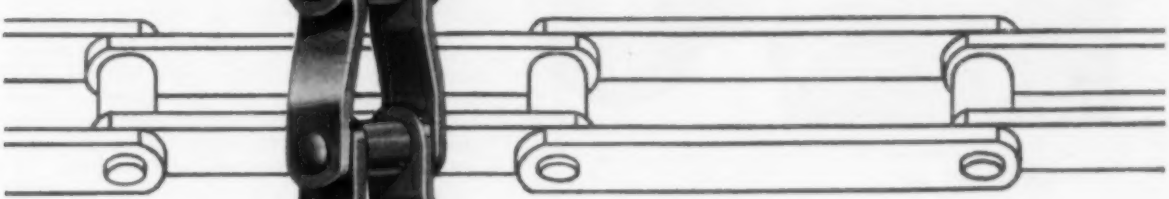
Heat-Treating Furnaces

When COST is an OBJECT

Whether that cost is first or operating, it will pay dividends to investigate the saving possibilities of Rex Chabelco Steel Chain. It has the *extra* strength, *extra* stamina and *extra* quality needed for longer trouble-free operation.

For drive or conveyor service, where loads are heavy, speeds slow to moderate . . . where operating conditions involve temperature extremes, dust, dirt or heavy shock loads—*these steel chains will save you important money.* And, they run on cast sprockets . . . another important cost-cutting advantage.

Why not have your Chain Belt District Sales Engineer check your chain requirements with you. He may be able to save you important money—he has for other Design Engineers. Meanwhile, send for Bulletin 53-59. Chain Belt Company, 4715 W. Greenfield Ave., Milwaukee 1, Wisconsin.



CHAIN BELT COMPANY

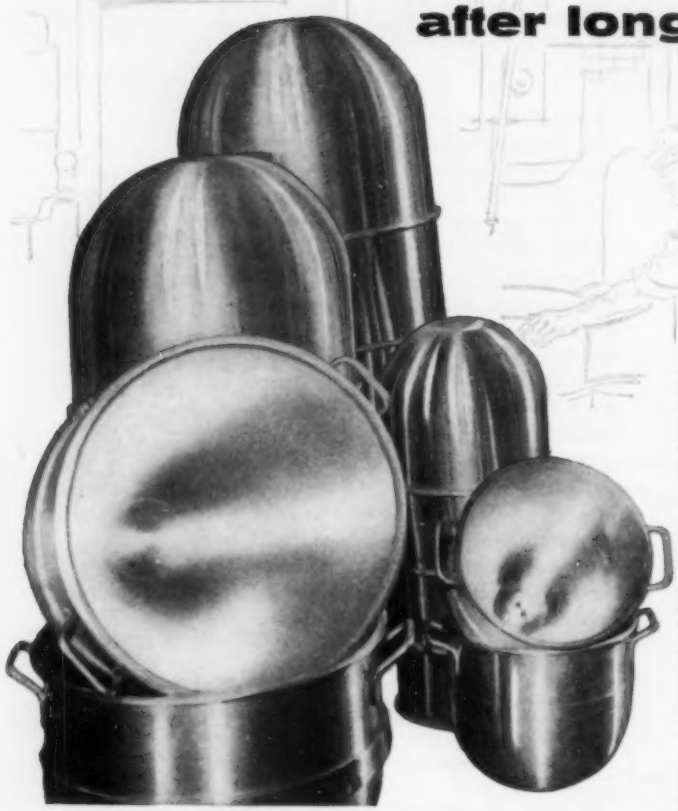
District Sales Offices in all Principal Cities

Mixing bowls made of Crucible stainless steel by American Car and Foundry Company, at its Milton, Pennsylvania plant.

CRUCIBLE STAINLESS STEEL

keeps its shine

after long, hard wear...



The fact is stainless steel improves with wear, for the more it is used the harder and smoother the surface becomes. And there is never any surface plating to wear on a stainless product, for stainless steel is *stainless* all the way through.

Yes, Rezistal® stainless is a *natural* for products that must take long hard service, or that must resist corrosion or wear, or stand up under daily cleaning with strong detergents. Take, for example, the stainless mixing bowls shown. They'll give many years of trouble-free service. And their smooth, sanitary surface makes them especially suited to the processing of baked goods, candy, cosmetics or chemicals.

Be sure you take advantage of all the money- and time-saving qualities of stainless steel. And be sure you specify Crucible stainless . . . made by the country's leading producer of special purpose steels. You'll get fast delivery of the grade and size you need when you call Crucible.

CRUCIBLE first name in special purpose steels

54 years of Fine steelmaking **STAINLESS STEELS**

CRUCIBLE STEEL COMPANY OF AMERICA, GENERAL SALES OFFICES, OLIVER BUILDING, PITTSBURGH, PA.

REX HIGH SPEED • TOOL • REZISTAL STAINLESS • MAX-EL • ALLOY • SPECIAL PURPOSE STEELS

Which is the CleCap?

...all of them

—ready for fast delivery on time!

If it's a cap screw, CleCap makes it. Whatever head style or size you want, whether you want ferrous or non-ferrous. You can get CleCap top-quality fasteners, on time, one or a million!

We're *The* cap screw specialists—that's why thousands of our customers stick to CleCap year after year. They can't beat the quality—and they know by happy experience that their friends at CleCap gladly knock themselves out to get them what they want when they want it.

That can be pretty important to you. Who pays when late deliveries shut down your production? . . . No fooling—it pays you to order your requirements from CleCap. You'll like the service you get.

CLEVELAND *Top Quality* FASTENERS

Ferrous and Non-Ferrous

Hex Head Cap Screws—Bright and High Carbon Heat Treated Steel, Brass, Silicon Bronze, Stainless Steel: ¼" to 2½" dia.
Socket Head Cap and Set Screws—Plain and Knurled: ¼" to 1½" dia. Also flat and Button Head Styles
Flat Head Cap Screws: ¼" to 1" dia.
Fillister Head: ¼" to 1¼" dia.
Set Screws—Square Head: ¼" to 1½" dia.
Milled Studs: ¼" to 1¼" dia.
Place Bolts: ¼" to 1½"
Structural Bolts
Tractor Bolts
Special Hot and Cold Headed Parts

Facilities to make larger diameters than listed.

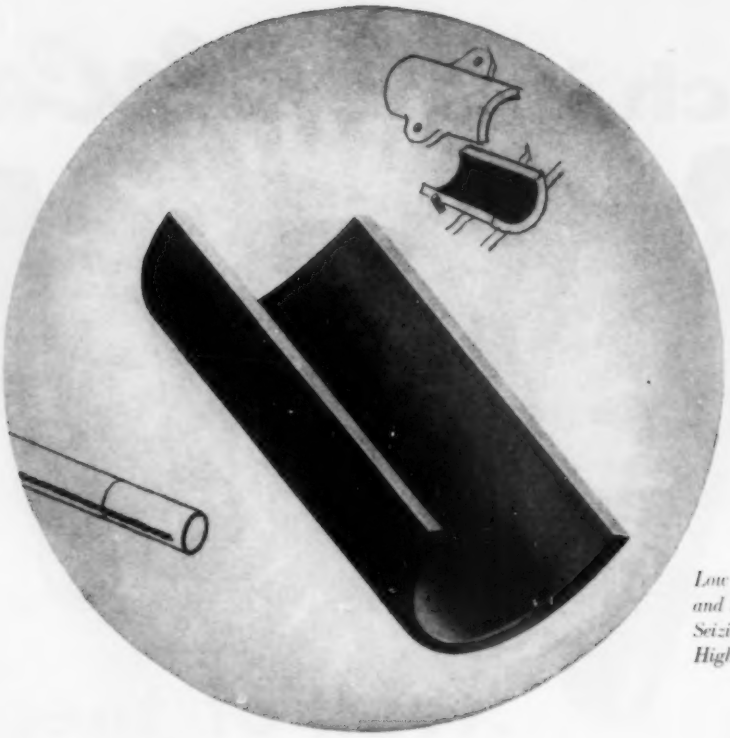
Ask Your Jobber for CleCap!

The Cleveland Cap Screw Company

2936 East 79th Street • Cleveland 4, Ohio • VUlcan 3-3700 TWX CV42

Warehouses: Chicago • Philadelphia • New York • Providence • Los Angeles

Originators of the Kaufman DOUBLE EXTRUSION Process



Low Friction Bushings and Sleeves Resist Seizing, Abrasion, High Temperatures

HAYNES STELLITE Bushings and Sleeves

Trade-Mark

...for handling Hot-Abrasive Materials

Bearing parts made of HAYNES STELLITE alloy resist seizing and galling. They are hard and abrasion resistant, and will withstand the pitting effects of many corrosives. They take a high polish and are easy to apply. Use them to reclaim worn shafts or bearing blocks, and to lengthen the life of new equipment.

Operate with Little or No Lubrication

Sleeves made of HAYNES STELLITE alloy can be used in areas where efficient lubrication is impossible. They resist seizing even when lubricants are diluted by gasoline, cleaning fluids, and other liquids that wash out an oil film. They operate at peak efficiency even when lubricants decompose under heat, or are destroyed by abrasive particles.

Tough and Abrasion-Resistant

Bearing parts made of HAYNES STELLITE alloy resist the abrasive effects of wet or dry materials such as fly ash, coke, metal powder, shale, and cement dust. They are hard enough to carry heavy loads, and tough enough to stand up under repeated stress.

Heat and Corrosion Resistant

These bushings and sleeves can be submerged in many acids, alkalies, and molten metals. Temperatures as high as 1500 deg. F. have little effect on their hardness, toughness, and dimensional stability.

For more information write for our 8 page booklet on half bushings and sleeves.

"Haynes" and "Haynes Stellite" are registered trade-marks of Union Carbide and Carbon Corporation.

HAYNES TRADE-MARK ALLOYS

HAYNES STELLITE COMPANY

A Division of Union Carbide and Carbon Corporation

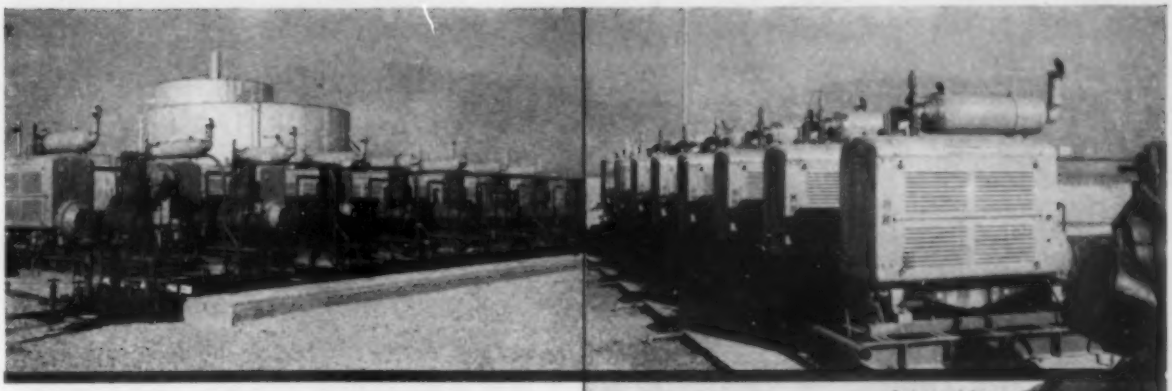
UCC

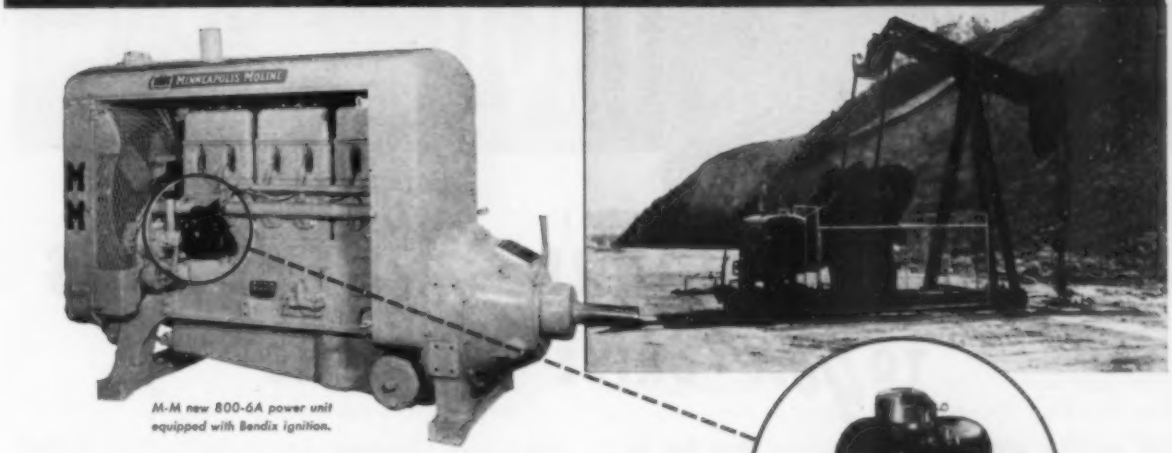
General Offices and Works, Kokomo, Indiana

Sales Offices

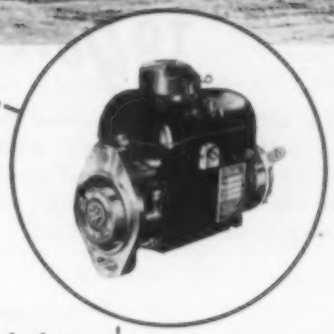
Chicago · Cleveland · Detroit · Houston · Los Angeles · New York · San Francisco · Tulsa

More power to the oil fields...





M-M new 800-6A power unit equipped with Bendix ignition.



with Minneapolis-Moline power units and Bendix ignition

Oil is the lifeblood of American industry. Minneapolis-Moline power units equipped with Bendix magnetos are helping materially to maintain a constant supply of this vital commodity. These versatile power units perform a great variety of services at many stages of petroleum production and processing.

The Bendix magneto selected by Minneapolis-Moline for this rugged service is a heavy-duty magneto with high electrical output for medium and large size engines of one, two, four and six cylinders. The magneto is supplied with fixed or variable spark and standard or low fire hazard ventilation. An impulse coupling provides for complete adjustment of lag angle and lug position.

Like all Bendix magnetos, the CBR series gives trouble-free performance for extremely long periods of time. Design simplification eliminates costly service maintenance.

Remember, Scintilla Division of Bendix manufactures a complete line of ignition for every industrial purpose. Our sales department will gladly furnish complete information.

SCINTILLA DIVISION
OF
Bendix
AVIATION CORPORATION
SIDNEY, NEW YORK

Export Sales: Bendix International Division, 205 East 42nd St., New York 17, N. Y.

FACTORY BRANCH OFFICES: 117 E. Providencia Avenue, Burbank, California • Brouwer Building, 176 W. Wisconsin Avenue, Milwaukee, Wisconsin • Stephenson Building, 6560 Cass Avenue, Detroit 2, Michigan
512 West Avenue, Jenkintown, Pennsylvania • 8401 Cedar Springs Road, Dallas 19, Texas
4 South Main Street, Dayton 2, Ohio

Bendix

MORE HP PER POUND • MORE HP PER CU. IN. • MORE HP PER DOLLAR

190,000 STANDARD *Stock* ANSWERS TO *Your* DRIVE PROBLEMS

Look closely at the cutaway views above. Note how the worm wraps around the gear and the gear around the worm. That's the double-enveloping principle of Cone-Drive gears. It gives you high load-carrying capacity, long life and less weight, all in an extremely compact unit.

Size for size, Cone-Drive speed reducers will out-perform any other worm geared speed reducer on the market.

Yet, you can select any one of 190,000 standard stock reducers to solve your specific drive problem the efficient way.

You can choose ratios from 5:1 to 4900:1.

You can handle loads from fractional to 800 hp.

You get all this with only 58 standardized mountings.

Cone-Drive gears offers this versatility because of their modern manufacturing methods. All parts for a given center distance—gears, mountings, bearings, housings, fan-cooling attachments and water cooling coils, etc.—are standardized whether you require worm under or over, gear shaft vertical or horizontal, single or double-extended shafts, right or left hand. All of these parts are completely interchangeable for a given center distance, too.

Find out more about Cone-Drive speed reducers. Ask for Bulletin 8901-50.

CONE-DRIVE GEARS

DOUBLE ENVELOPING GEAR SETS & SPEED REDUCERS

Division, Michigan Tool Company

7171 E. McNichols Road • Detroit 12, Michigan

18% PRODUCTION INCREASE

Maintenance Practically Eliminated

Winding TV power transformer coils at Sparton Radio-Television

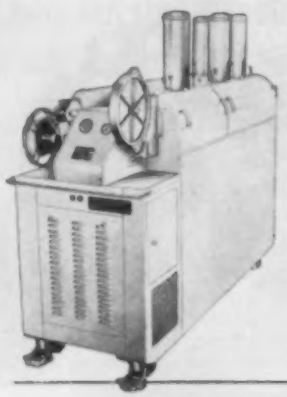
VICKERS

VARIABLE SPEED Hydraulic Transmission

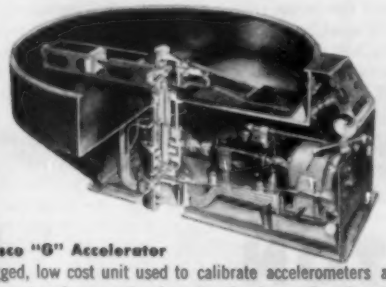
Hourly production was increased 18% when these coil-winding machines at Sparton Radio-Television were equipped with the Series TR3 Vickers Variable Speed Hydraulic Transmission. This improvement resulted from the superior control features inherent in the transmission: (1) extremely quick and smooth variations in speed, (2) maximum torque at low rpm, (3) instantaneous starting and stopping.

While the previous drives required maintenance approximately once a week, the Vickers transmissions have needed attention only three or four times since they were installed four years ago. They have built-in automatic overload protection and they are automatically pressure lubricated by the power-transmitting medium (oil).

Perhaps you have an application where this Vickers Variable Speed Hydraulic Transmission will make similar improvements and economies. Ask the nearest office listed below for Bulletin 47-40a.



Motion Picture Film Processing Machine By Houston Fearless Corp.—Another application where stepless variable speed and constant torque of Vickers Hydraulic Power Transmission provided much more satisfactory operation.



Genisco "G" Accelerator
A rugged, low cost unit used to calibrate accelerometers and other equipment under operational acceleration forces. Speed settings must be accurate and precisely maintained over extended operating periods. Driven by Vickers Variable Speed Hydraulic Transmission.

VICKERS Incorporated
DIVISION OF THE SPERRY CORPORATION
1454 OAKMAN BLVD. • DETROIT 32, MICH.

Application Engineering Offices: ATLANTA • CHICAGO (Metropolitan) CINCINNATI • CLEVELAND • DETROIT • HOUSTON • LOS ANGELES (Metropolitan) • NEW YORK (Metropolitan) • PHILADELPHIA (Metropolitan) PITTSBURGH • ROCHESTER • ROCKFORD • SEATTLE • TULSA WASHINGTON • WORCESTER

6486

ENGINEERS AND BUILDERS OF OIL HYDRAULIC EQUIPMENT SINCE 1921

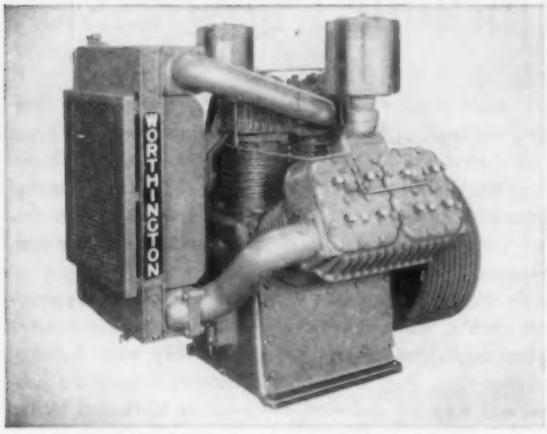
COMPRESSED AIR...
do you get it economically?

FOR SMALLER QUANTITIES of compressed air, Worthington's Balanced Angle Compressor is your best bet. Mills, machine shops and laundries all over praise the quietness and efficiency of this dependable unit. Sizes range from ½ through 15 hp.

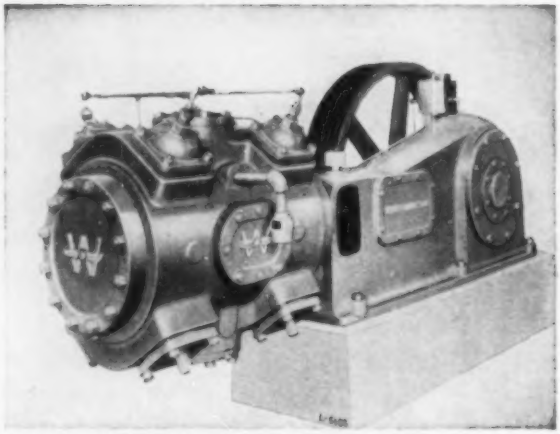
If you can't answer this one, you might find some investigation worthwhile.

When is a compressor worn out? What model and horsepower is the best answer for your application? How much reserve capacity should you allow for?

Providing the answers to these and other questions about air compression is all in the day's work for Worthington. We've got the widest line to choose from, so you'll know any new Worthington equipment you get is "right" for your particular job.



COMPACTNESS AND EASY INSTALLATION are the big advantages of Worthington Radial Air Compressors, used where larger quantities of air are needed. Like all Worthington compressors, the radial is equipped with our exclusive Feather* Valve. Sizes from 25 to 100 hp.



FOR THE REALLY BIG JOBS, specify the horizontal, water-cooled HB—the work horse of the Worthington compressor line. We've had reports about 30-year-old HB's that are giving the same good service as when first installed. Sizes from 7½ on up to 125 hp.

*Reg. U. S. Pat. Off.

Get the whole story about these modern compressors. Write for Bulletin WP-1099-B52 to Worthington Corporation, Pump and Compressor Merchandising Division, Harrison, New Jersey.

WORTHINGTON

PC.3.14

SPECIFY THESE WORTHINGTON STANDARD PRODUCTS ON YOUR EQUIPMENT

Compressors • Pumps • Multi-V-Drives • Variable Speed Drives

New facts for your file on U·S·S HIGH STRENGTH STEELS

Truck body platform frames built of USS COR-TEN steel are 20% lighter...4 to 6 times more rust resistant

In truck mixer parts, USS MAN-TEN steel adds strength, increases resistance to abrasion, impact and vibration

In this 4½ cu. yd. Lite-weight, Heavy Duty Hi-Boy Truck Mixer built by Blaw-Knox Company, Pittsburgh, Pa., the mixing drum, mixing blades, charging hopper and discharge chute are made of USS MAN-TEN steel. In all these parts which are subjected to the highly abrasive action of the concrete batch, MAN-TEN steel's greater resistance to abrasion plays an important part in prolonging life and keeping maintenance costs and downtime to a minimum.

MAN-TEN steel's high endurance limit, 40% greater than carbon steel, and its high yield point of 50,000 psi are additional properties that pay off in increasing the durability of this equipment.

During the past 20 years, USS High Strength Steels—USS COR-TEN, USS MAN-TEN and USS TRI-TEN—have been used in materials-handling, road-building and excavating equipment of all kinds to reduce weight, increase working capacity and to give it the stamina to stay on the job.

Find out how these "steels that do more" can be applied to improve your equipment—how readily they can be fabricated—and how little they cost to use. A letter to our nearest district office will bring you this information.

By using 10-gage USS COR-TEN steel in place of 8-gage hot rolled carbon steel, Giant Manufacturing Co., Council Bluffs, Iowa, obtains maximum strength with minimum weight in the platform frames of their farm truck bodies.

This construction, which gives farmers and truckers several hundred pounds more loading capacity in these units—and thus cuts transportation cost per mile of load—has been used almost exclusively in Giant trucks since 1946.

"During this time," says the manufacturer, "we have not had a failure due to distortion or corrosion of the platform frames. Our fabrication department states that shearing and forming USS COR-TEN steel, using power equipment, is comparable to equal gages of regular carbon steel. COR-TEN steel's welding properties are excellent . . . it is easily prepared for application of enamel finish and has absolutely no tendency to flake or peel the finished coat."

Another well-known builder of farm wagons says, "We have found that the use of high strength steels is almost a must in the manufacture of farm equipment. All farm implements are subject to terrific abuse in the field and are generally without any protection whatsoever from the elements. The anti-corrosive qualities of high strength USS COR-TEN steel are naturally a major selling point in equipment of this type."

USS MAN-TEN steel saves weight, ensures longer life, in air-balanced oil pumping unit

Designers of equipment for the oil industry have found in USS High Strength Steels an economical and practical solution of many of their problems. How to reduce weight? How to increase strength? How to resist corrosion? How to prolong life?

Typical is this application of USS MAN-TEN steel in the walking beam of this ultra-modern air balanced pumping unit built by the Parkersburg Rig and Reel Company, Parkersburg, W. Va.

By using USS MAN-TEN steel construction in the 24 in. walking beam in place of carbon steel, the weight of this important member has been reduced 16.6%. Yet, because USS MAN-TEN steel has a yield point of 50,000 psi—one and a half times that of carbon steel—the lighter beam is much stronger. Additional durability is ensured by the fact that MAN-TEN steel has 40% higher fatigue strength, thus providing greater resistance to vibration and reversal of stresses.

USS

UNITED STATES STEEL CORPORATION, PITTSBURGH · COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO
TENNESSEE COAL & IRON DIVISION, FAIRFIELD, ALA. · UNITED STATES STEEL SUPPLY DIVISION, WAREHOUSE DISTRIBUTORS
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

UNITED STATES STEEL

New facts for your file on U·S·S CARILLOY STEELS

Improved suspension system of "Patton 48" features torsion bars of Carilloy steel

• In the army's newest medium tank, the Patton 48, torsion bars made from U·S·S Carilloy steel do a better job of cushioning riding shocks and take less mounting space than suspension systems used in World War II tanks.

In rugged field tests of the Patton 48, the torsion bars constantly flex, twist, and vibrate as the tank rumbles over trenches and scales 3-foot walls. U·S·S Carilloy 8660, a high quality electric furnace steel, performs exceptionally well in this torturous service.

U·S·S Carilloy steels are solving many tough jobs like this in both military and civilian applications. And it will pay you to look for a Carilloy steel when you need maximum strength, light weight, good corrosion resistance, or any combination of these properties in heavy-duty parts that must be small in size.

Cost cut 75% on wing flap supports with Rolled Structural T-sections of Carilloy steel

By switching from 2¼" x 3¼" alloy steel *bars* to hot-rolled T-sections of U·S·S Carilloy 4140 steel, J. C. Peacock Company and Consolidated Vultee Aircraft Corporation have reduced the cost and *improved the quality* of wing flap supports for Model 340 Convair airliners.

Flap tracks made of Carilloy T-sections not only are stronger than those formerly used, but require 4 hours less machining time and are machined with 60% less scrap loss. Finished tracks now cost only one-fourth as much as they used to.

As J. C. Peacock and Convair did, you will find exactly the alloy steel you need in U·S·S Carilloy. Carilloy steels are produced in the widest available range of analyses, sizes, forms, and heat treatments. They readily meet with the highest quality standards. If you need alloy steel of *any type* get in touch with our nearest District Sales Office.

U·S·S Carilloy steel produced in wide variety of plate, sheet, and strip

You can order flat-rolled *Carilloy steel* in anything from a razor blade strip to armor plate for a battleship. In U·S·S Carilloy, you get the widest selection of alloy steel plate, sheet, and strip that is obtainable from one producer. One source of supply makes purchasing easier, assures you consistent quality, and simplifies manufacturing problems.

Remember, too, when you buy Carilloy steels you have at your service, every day, the best metallurgical talent available. Our metallurgists have intimate knowledge of all types of alloy steels and their most economical fabrication. These men often can help you cut costs by offering practical suggestions on engineering and production.

For more information about Carilloy plate, sheet, and strip, and for free metallurgical assistance, get in touch with our nearest District Sales Office.

USS

UNITED STATES STEEL CORPORATION, PITTSBURGH · COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO
TENNESSEE COAL & IRON DIVISION, FAIRFIELD, ALA. · UNITED STATES STEEL SUPPLY DIVISION, WAREHOUSE DISTRIBUTORS, COAST-TO-COAST
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

UNITED STATES STEEL

New facts for your file on

U·S·S STAINLESS STEEL

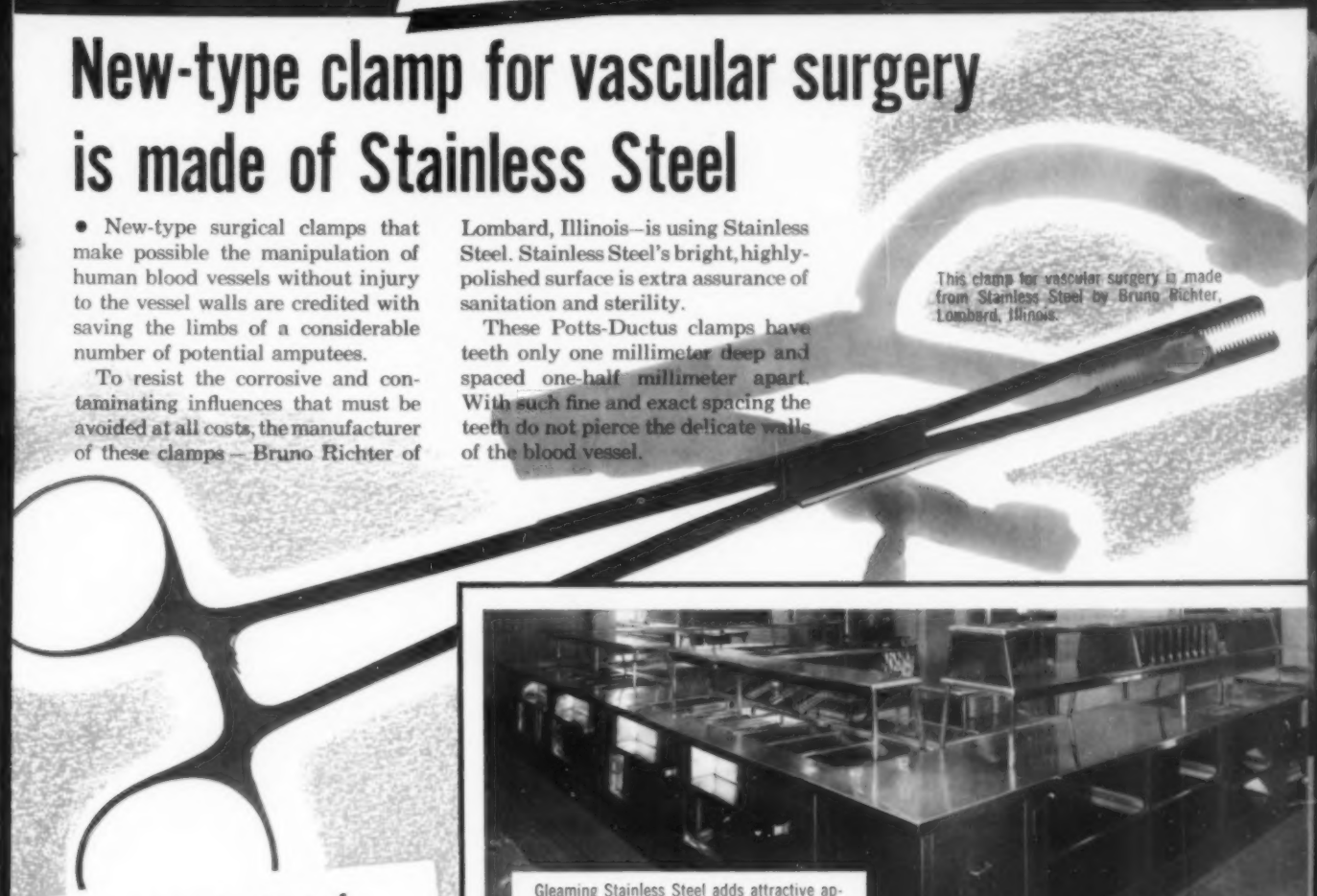
SHEETS · STRIP · PLATES · BARS · BILLETS · PIPE · TUBES · WIRE · SPECIAL SECTIONS

New-type clamp for vascular surgery is made of Stainless Steel

• New-type surgical clamps that make possible the manipulation of human blood vessels without injury to the vessel walls are credited with saving the limbs of a considerable number of potential amputees.

To resist the corrosive and contaminating influences that must be avoided at all costs, the manufacturer of these clamps – Bruno Richter of Lombard, Illinois—is using Stainless Steel. Stainless Steel's bright, highly-polished surface is extra assurance of sanitation and sterility.

These Potts-Ductus clamps have teeth only one millimeter deep and spaced one-half millimeter apart. With such fine and exact spacing the teeth do not pierce the delicate walls of the blood vessel.



This clamp for vascular surgery is made from Stainless Steel by Bruno Richter, Lombard, Illinois.

Take advantage of Stainless Steel in your designs and in your selling

Here are more applications typical of the thousands in which Stainless Steel has been used to improve design and add sales appeal. The wide range of valuable properties available in Stainless Steel makes it the ideal material for many, many jobs.

Put Stainless to work for you. It will pay its own way and give you a good return on your investment—especially when it is perfected, service-tested U·S·S Stainless Steel.

Gleaming Stainless Steel adds attractive appearance and a host of other benefits to the employee cafeteria at H. J. Heinz Company, Pittsburgh. It was fabricated by Tyson Metal Products Company, Pittsburgh.

Stainless Steel's ease of cleaning makes it best for cafeteria use

Food handling is a "natural" for Stainless Steel. Stainless gives you an unmatched combination of sanitary qualities, ease of cleaning, a smooth, non-porous surface, resistance to corrosion and long life.

This cafeteria equipment was fabricated for H. J. Heinz Company, Pittsburgh, Pa., by Tyson Metal Products Company, Pittsburgh. It is made of a nickel-chromium grade of Stainless Steel.

USS

UNITED STATES STEEL CORPORATION, PITTSBURGH · COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO
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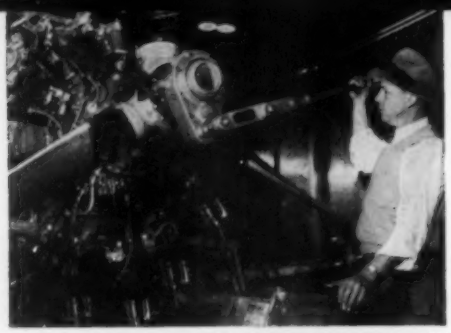
UNITED STATES STEEL



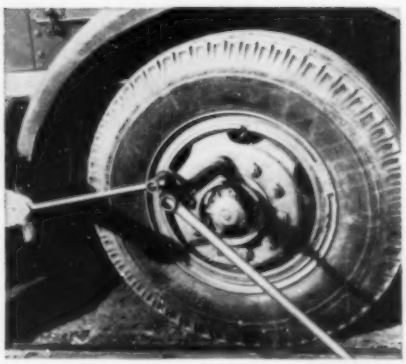
Shelby and Sweeney tame a tough nut

• The Sweeney POWERENCH is a rugged nut turning tool specifically designed with geared action for tightening or loosening the nuts on dual wheels, aircraft propeller shafts, diesel engine cylinder heads, railroad locomotives, and for countless other heavy-duty applications.

Super tough equipment calls for super strong materials. That's why Shelby Seamless Mechanical Tubing—in sizes from 1⅛ in. O.D. to 5⅝ in. O.D.—is used in the manufacture of POWERENCH assemblies. The great strength, complete uniformity, and extreme dimensional accuracy of Shelby Seamless make it the ideal mechanical tubing for the fabrication of such heavy-duty materials. Moreover, it is safe and workable—possessing excellent machining and superior welding properties.

Produced to exacting standards by the world's largest manufacturer of tubular steel products, Shelby Seamless Mechanical Tubing is available in a wide range of diameters, wall thicknesses, various shapes and steel analyses. Call on our engineers for recommendations. They will be glad to make a study of your particular requirements and help you apply Shelby Seamless to your specifications.

NATIONAL TUBE DIVISION
UNITED STATES STEEL CORPORATION, PITTSBURGH, PA.
(Tubing Specialties)
COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO, PACIFIC COAST DISTRIBUTORS
UNITED STATES STEEL EXPORT COMPANY, NEW YORK



All Shelby Seamless Tubing is pierced from solid billets of uniform steel. This is the one manufacturing method that assures absolute uniform wall strength.

USS SHELBY SEAMLESS MECHANICAL TUBING

USS

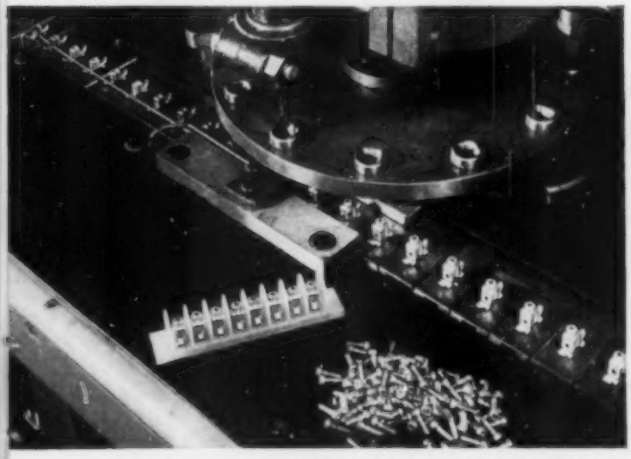
4-1226

UNITED STATES STEEL

Users praise Phillips Cross-Recessed-Head Screws

"90% OF THE SCREWS IN THE GRAY AUDOGRAPH ARE PHILLIPS," estimates William S. Sherman, Director of Sales operation. With the introduction of the Phillips self-tapping screw the inspection of each threaded hole has been eliminated. Nor is "head-splitting" or "burring" any longer a factor. Here Mary Borkowski fastens amplifier unit to main frame with Phillips screws.

THE CLARK CONTROLLER COMPANY makes some highly specialized control equipment on which Phillips screws are used. Their neat, compact appearance enhances the design of the units and their positive gripping action prevents driver slippage that would otherwise mar the surface. "There is no comparison in the beauty of design offered by the attractive Phillips head," states R. Russo, Manager of General Engineering Standards Department. Larry Larkin here installs Phillips screws in a Clark push-button station.



BUCHANAN'S REVOLUTIONARY NEW TERMINAL STRIP uses a specially designed Phillips screw that, according to Albert Mittleman, Plant Superintendent and Production Manager "has enabled us to design our own automatic, hopper-fed assembly machine which permits us to put the sub-assembly of these terminal strips on an assembly line basis." Closeup of this machine is shown above.

MANUFACTURERS OF PHILLIPS CROSS-RECESSED-HEAD SCREWS

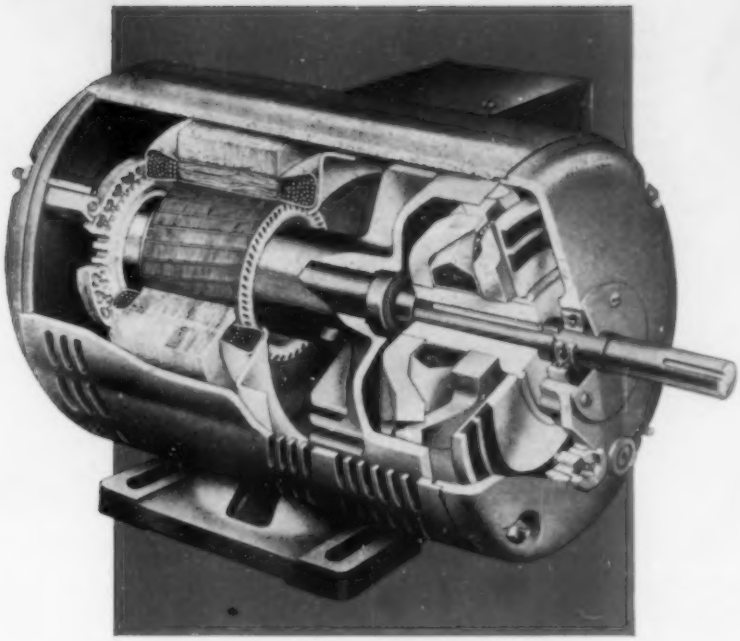
THE FASTENERS OF TODAY... AND OF THE FUTURE

X marks the spot

... the mark of extra quality

American Screw Company • Atlantic Screw Works, Inc. • The Blake & Johnson Co. • Central Screw Company • Continental Screw Company • The Eagle Lock Company Elco Tool and Screw Corporation • Great Lakes Screw Corporation • The H. M. Harper Co. • The Lamson & Sessions Company • National Lock Company • The National Screw & Manufacturing Co. • Parker-Kalon Div. General American Transportation Corporation • Pheoll Manufacturing Co. • Rockford Screw Products Co. • Scovill Manufacturing Co. • Shakeproof • The Southington Hdwe. Mfg. Company • Sterling Bolt Company • Wales-Beech Corp.

IRON
SPECIAL ALLOYS
PARKER
OFFERS a CHOICE
in Powdered Metal Materials
NOW—whatever the product requirement, Parker can supply the powdered metal part. Gears, bearings, bushings, cams, lever arms or intricate parts can be yours in almost any powdered material. Parts of basic metals and special alloys are regularly produced in our new plant. Call on Parker for your Powdered Metal parts.
COPPER
NICKEL-SILVER
BRASS
POWDERED METAL DIVISION OF
PARKER
WHITE METAL CO.
2153 McKinley Avenue
ERIE, PENNSYLVANIA



Now—Dynamatic Makes Ajusto-Spede Motors Available in Fractional Horsepower Sizes

The addition of 5 new fractional horsepower models to the existing Ajusto-Spede line extends the available range of these adjustable speed drives from ¼ horsepower to 75 horsepower.

This compact, self-contained unit is an integral combination of AC constant speed induction motor, eddy current coupling, and electronic control.

All fractional horsepower Ajusto-Spedes are rated 115/220 volts, single phase or 220/440 volts, 3 phase. Sizes are ¼, ⅓, and ½ horsepower at 1600 RPM; ½ and ¾ horsepower at 3200 RPM.

If you have fractional horsepower adjustable speed drive problems, write for a copy of the Dynamatic Bulletin FAS-2. Bulletin GB1, which describes other Dynamatic Eddy Current products, is also available.

Ajusto-Spede Advantages:

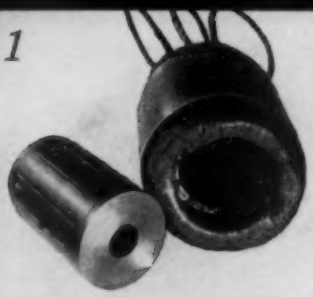
- ★ Constant torque speed range: 10 to 1 with 1600 RPM Ajusto-Spedes; 20 to 1 with 3200 RPM units.
- ★ Control accuracy: 2 per cent of top speed at any point within the speed range.
- ★ Minimum wiring to power line.
- ★ Remote "one knob" control operation up to 100 feet.
- ★ Rugged plug-in type integral one-tube electronic control.
- ★ Permanently sealed grease-packed bearings.
- ★ Power output shaft extension at both ends of drive.

DYNAMATIC®

DIVISION EATON MANUFACTURING COMPANY

KENOSHA, WISCONSIN • General Offices: Cleveland, Ohio

1



R & M Polyphase motor parts, consisting of rotor and stator, horizontal position. Light weight and reserve power for heavy duty use were the most important motor characteristics required.

2

This motor had to be lightweight, powerful and capable of running for long periods at 36,000 R.P.M. It's dynamically balanced with a diamond-turned commutator and specially anchored windings.

3

This powerful R & M Motor has a high starting torque for quick response; it runs cooler than normal, it's exceptionally quiet, and it's *compact*. Extra-heavily insulated, dynamically balanced, 100% inspected.

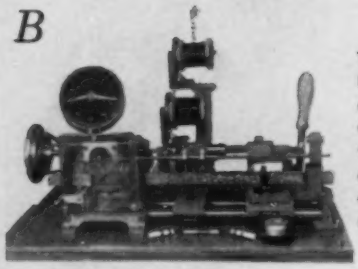
4

Variable speed was a must for this R & M Motor—to permit a wide selection of speeds without need for changing belts or pulleys. Motor is ¼ HP, AC-DC 5000 R.P.M., ball bearing equipped and open ventilated.

A

The ultra-high-speed SKIL Grinder, made by Skil Corporation, packs twice the power per pound of other grinders of similar weight. Tool and die makers say it's great!

B



The Geo. Stevens Model 125 Progressive Universal Winder made by Geo. Stevens Mfg. Co., Inc., world's largest manufacturer of coil-winding machines. One of a complete line of R & M Motor-equipped machines.

C

The powerful, easy-to-handle Buckeye Hi-Frequency Sander. It's ideal for automotive and industrial applications where tools are subjected to continuous, heavy duty service. R & M furnishes motors to Buckeye Tools Corporation in capacities from 3/16 to 4 HP.

D

The IBM Executive made by International Business Machines Corp., the only typewriter manufacturer exclusively producing electric machines. It's the mark of a modern office!

Can YOU match these motors to these tools and machines?

Here are some R & M fractional horsepower motors, and the machines for which they were selected or designed. Can you guess which goes with which? The answers are printed at the right . . . what was *your* score?

THE ANSWERS

R & M motors and motor parts, and the machines on which they are specified as standard, match up as follows:

1-C 2-A 3-D 4-B

ON COMPLETE MOTORS OR MOTOR PARTS . . .

Don't "guess" . . . let Robbins & Myers do a *scientific* job of matching the all-important motor to your product! Regardless of whether you need a motor that's standard or custom-designed . . . motors with special housing designs or motor parts to fit your housings, remember that R & M Motors are powering all types of equipment, such as . . . . . .

Portable Saws
Drills
Nut Setters
Hammers
Routers
Screw Drivers
Hedge Trimmers
Lawn Mowers
Nibblers
Lock Mortisers
Valve Grinders
Vacuum Cleaners
Files
Sanders
Pumps
Compressors
Hones
Business Machines
Cast Cutters
Food Mixers
Polishers
Planers
Portable Grinders
Sirens
Hair Driers
Advertising Devices
Ventilating Equipment
Oil Burners
Surgical Instruments
Grease Guns
Vibrators
Die Sinkers
Waxers

why you get better performance from a Fractional Horsepower Motor that's matched to your machine!

The most important single factor in the performance of any motor-driven product is the *motor itself*. That's why the engineers who designed the well-known tools and machines at the left came to Robbins & Myers to get the *right motor for the job*. Like many other R & M customers, they knew that the motor which met *every requirement*—one by one—was bound to improve the performance of their products, and *last longer* as well.

Selecting such a motor isn't simple. You can, of course, *look* at these examples, and try matching the motor to the machine for which it was designed. It's easy to guess, but in your business you can't afford guesswork.

Neither can we. That's why we've set up such systematic methods for designing motors. For example, we often use the R & M "Electrical Slide Rule." In this unique machine we first set up the electrical equivalents of motor *operating conditions;* then test equivalents of various motor *designs*. Result? Required motor characteristics can be calculated in minutes instead of days!

In some cases, the answers point to a standard motor. We have many such motors to choose from. But in other cases where special motors are indicated, we can do a fast, thorough, economical job of custom-designing a motor that's *exactly right* for your product.

In short, our experience—and our approach to your problem—isn't limited to standard motors we have "on the shelf."

If you feel that the motors you're now using aren't 100% right—in quality or in performance characteristics—we can make a real contribution to the solution of your problem. Use the coupon below . . . you will get the information you want promptly.

if it's an R&M it's the Right Motor!

ROBBINS & MYERS, INC.

SPRINGFIELD 99, OHIO • BRANTFORD, ONTARIO

ROBBINS & MYERS, INC., MOTOR DIVISION, PD
SPRINGFIELD 99, OHIO:

Please send me, without obligation, information on:

- ☐ Motor Parts for Portable Tools
- ☐ Universal Motors
- ☐ Capacitor Motors
- ☐ Universal and DC Motors
- ☐ R & M "All-Weather" Motors—up to 125 HP
- ☐ Please have a Motor Specialist call

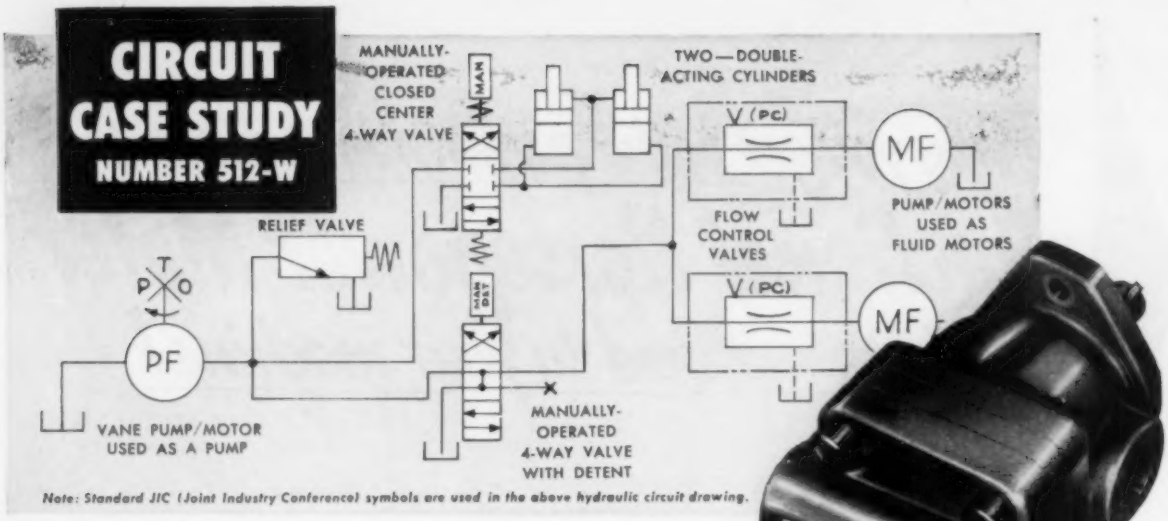
Product we manufacture: _____

Name _____ *Title* _____

Company _____

Street _____

City & State _____



Underwater weed-cutters powered by DENISON HydrOlLic Pump/Motors

Unusual Circuit Also Features Denison Valves and Controls

Denison Controls and **Pump/Motors** power triple cutter bars in a fleet of boats specially developed to clear shallow inland waterways of weeds and other vegetation.

The circuit, shown above, affords positive control and power to three cutter bars, mounted on each side and across the bow of the boats. It replaces a complex, hazardous mechanical setup of open, rotating shafts, gears, pulleys, chains and belts.

The gasoline engine which powers the boat also drives a Denison **Pump/Motor** which acts as a pump.

Two additional **Pump/Motors**, one at the rear of each side-mounted cutter bar, drive the cutters through 5-to-1 reduction gearing and eccentrics. Drive rods delivering power to the cutters are interconnected by bell cranks.

A Denison 4-way valve, with detent, controls these two **Pump/Motors**. The detent permits the operator to leave the valve in either the "operating" or "off" position without holding the lever.

A Denison relief valve limits system pressure to the maximum pre-set rating. The mechanical linkage formerly used was subject to severe damage if the cutters struck an obstacle. Now, however, the cutters merely stall, and excess flow "spills" through the relief valve.

A second Denison 4-way valve with a closed-center spool controls double-acting cylinders which raise and lower the cutter bars. By simply centering this valve control, the operator can hold the cutters at any height.

This type of circuit emphasizes advantages of Denison **Pump/Motors**. Each unit is ready for either pump or motor duty *without alterations!* A single "spare" can replace any of the three units, in any of the boats. **Pump/Motors** are single-stage, vane-type power packages with hydraulically balanced vanes, and simplified three-unit construction. They stand up under *long, hard, continuous duty* at pressures up to 2000 psi. Four sizes—each with a choice of cam rings for different needs—offer pumping capacities from 3 to 82 gpm . . . motor capacities from 8 to 98 hp (13 to 257 inch-pounds of torque per 100 psi.) All models can provide either clockwise or counterclockwise rotation.

Denison offers an outstanding line of high pressure oil hydraulic pumps, motors and controls, for pressures to 5000 psi. Designed with skill and knowledge gained through twenty-five years of leadership in oil hydraulics, they have the compact ruggedness needed for exacting, heavy-duty demands. Wherever you need closely adjustable power and control with unlimited operating flexibility, specify HydrOlLics. Write for more details.

The DENISON Engineering Company, 1157 Dublin Road, Columbus 16, Ohio

"from qwertyuiop to zxc vbnm,./- DIE CASTING helps me type faster, better and longer" . . .

CASE HISTORIES FROM MT. VERNON FILES

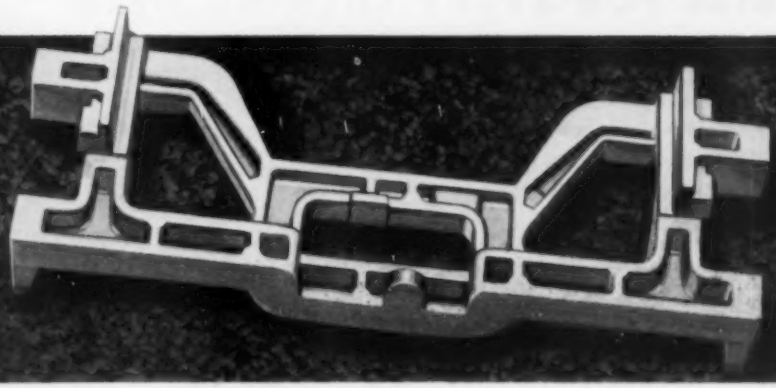
The new Smith-Corona "Eighty-Eight" is really a beauty. "Designed and built to out-perform any office typewriter ever made" is what its makers say about it.

And this is what they also have to say about the Mt. Vernon die casting shown below, which forms an essential part of the "Eighty-Eight.":

"This particular casting was designed for maximum torsional, compressive, and tensile strength. In an analogy of the automobile industry, this casting might be called the 'engine mounting' of a typewriter; the engine of the typewriter being the typebar segment. Because of the high strength characteristics needed for an 'engine mounting', we selected die cast aluminum. Other reasons for selecting die casting are its high degree of accuracy in contour and the lower cost of machining processes."

Whatever *your* product, whether simple or intricate, consult with us. We have up-to-the-minute facilities for die casting aluminum and zinc, and a vast reservoir of experience in die making. It's highly possible that we can help you, as we helped Smith-Corona, to lower unit costs . . . show you the way to improved products, too.

MT. VERNON
DIE CASTING CORP.
STAMFORD, CONNECTICUT



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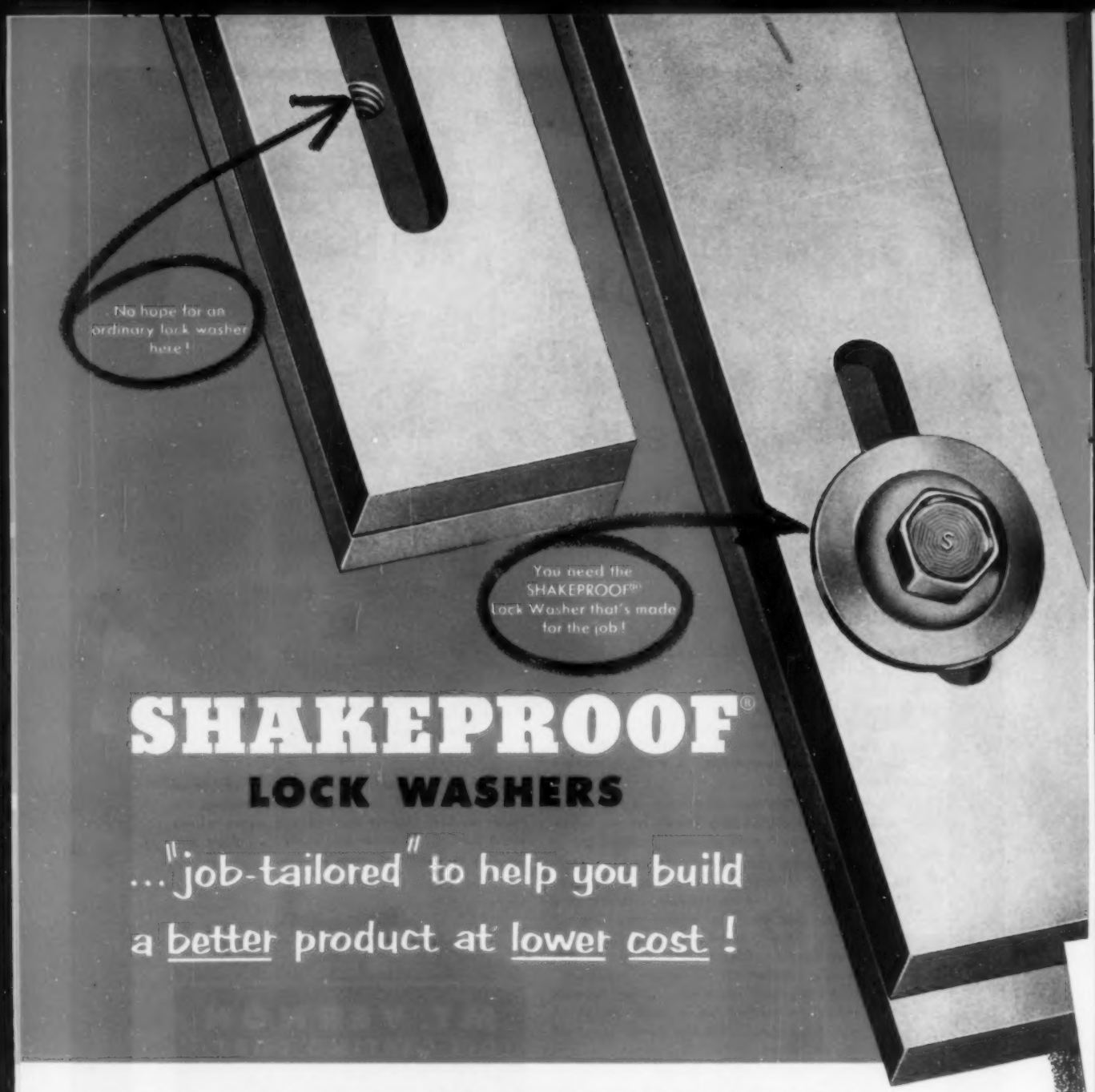


SHAKEPROOF®
LOCK WASHERS

...*"job-tailored"* to help you build a better product at lower cost!

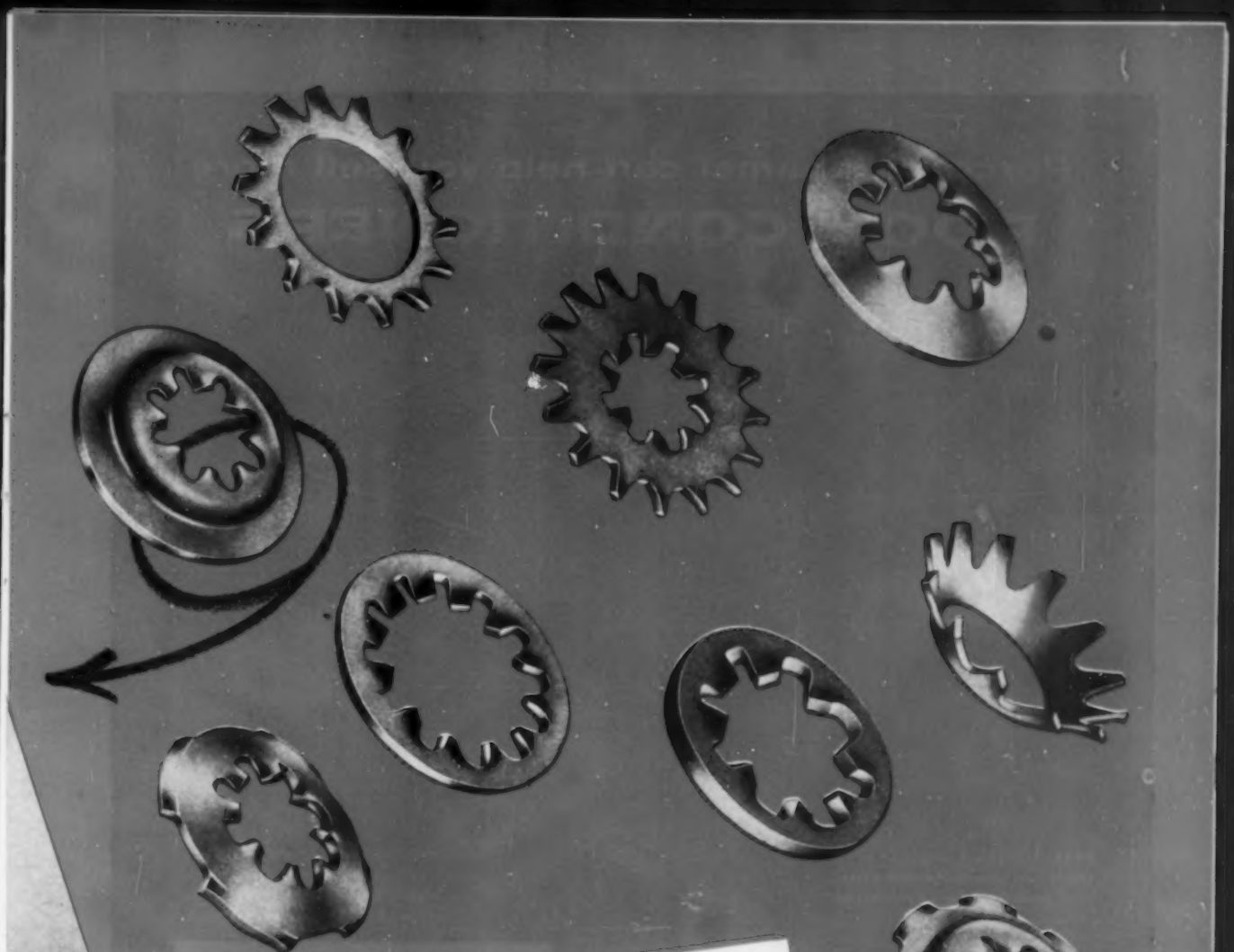
A TYPE AND SIZE FOR EVERY LOCKING NEED

The Shakeproof Dome Type Lock Washer above locks as it spreads the load over an elongated clearance hole . . . a job no other washer can perform so efficiently. Since only one washer is required, the flat washer formerly used is completely eliminated . . . a savings in assembly time *plus* a savings in material costs. And most important, Shakeproof tapered twisted teeth lock tight . . . then lock tighter as vibration increases.

Remember—all SHAKEPROOF Lock Washers give you greater assembly efficiency plus high locking performance, *because they're made for the job!*

SHAKEPROOF

"Fastening Headquarters"®
DIVISION OF ILLINOIS TOOL WORKS
St. Charles Road, Elgin, Illinois • Offices in principal cities
In Canada: Canada Illinois Tools Limited, Toronto, Ontario



For maximum savings buy them

PRE-ASSEMBLED!

SEMS-by-SHAKEPROOF

SHAKEPROOF Lock Washers, pre-assembled with screws, come to you as SEMS. Washers can't fall off, can't get lost. Every screw locks tight every time. SEMS are easy and fast to use—eliminate separate handling, speed production.

KEPS®

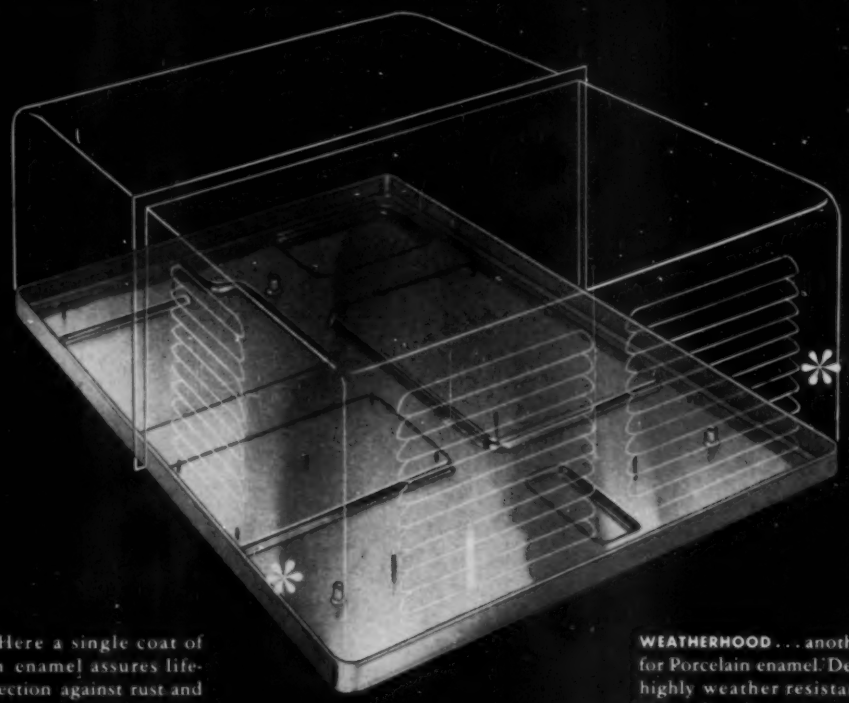
SHAKEPROOF Lock Washers, pre-assembled with nuts, come to you as KEPS . . . give you same advantages as SEMS. They assure the right lock washer for the job, improve product quality and simplify purchasing and inventory control.

FREE testing sample kit

Test Shakeproof Lock Washers on your own products . . . right in your own product laboratories. See how they lock even tighter as vibration increases; improve quality . . . and cut costs in your assembly. Send for your kit now.

Porcelain enamel can help you sell more!

ROOM CONDITIONERS



BASE . . . Here a single coat of Porcelain enamel assures lifetime protection against rust and corrosion.

WEATHERHOOD . . . another place for Porcelain enamel. Decorative, highly weather resistant, easily cleaned, and a *permanent* finish.

Rust and corrosion are stopped cold by a single coating of Porcelain enamel. And it costs so little to give users this extra protection against early deterioration. In a highly competitive field such as *room conditioning*, this could make a big difference in a company's sales—especially so in areas where salt-laden moisture in the air plays havoc with ordinary materials and finishes.

Several companies are already experimenting with Porcelain enameled *bases* for their room conditioners. Some are considering it for the *weatherhood*, two or three for the *entire cabinet*. This could be the big news of the industry a year hence . . . and welcome news to buyers looking for top value in room conditioners.

Designers will do well to consider Porcelain enamel in their plans for "best sellers". While there's nothing difficult about it, you do have to *plan* for Porcelain enamel. Why not call us in and let us help you?

PORCELAIN ENAMEL belongs in your PRODUCT-PLANNING

Only Porcelain enamel, the *fused-in* finish, gives you all these advantages:

1. Permanent, handsome appearance
2. Rust and corrosion resistance
3. High alkali and acid resistance
4. Easy cleaning and low maintenance
5. Long wearing, tough, durable
6. High heat resistance
7. Wide consumer acceptance

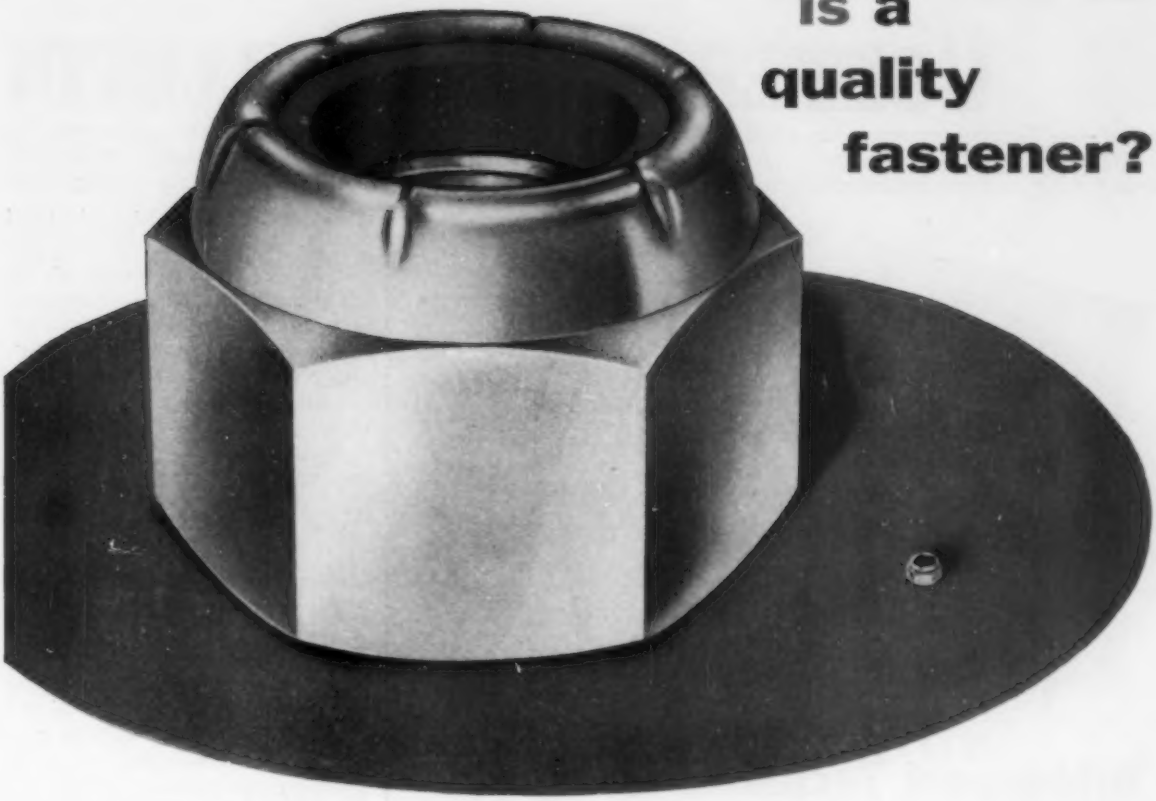
FERRO

FERRO CORPORATION

Porcelain Enamel Division

4150 EAST 56TH STREET • CLEVELAND 5, OHIO

What size is a quality fastener?



Here are two ELASTIC STOP® nuts.
Each has the familiar red locking collar. Each is self-locking, vibration-proof and can be reused many times. Each is a fast, readily assembled one-piece unit . . . will maintain accurate adjustment anywhere on a bolt. Each will afford positive protection against thread corrosion . . . prevent liquid seepage along bolts. Each is manufactured in quantity. Each is exactly controlled as to quality of raw material, finished dimensions, class of thread fit, seat squareness and finish. Each has a record for precision and uniformly high performance that is unmatched.

But . . . one measures 1/10 inch across the flats; the other, 4 inches. Between these two, there are more than 530 different hex nuts in the ESNA line. They are the result of variations in height, material, finish and size.

Look to ESNA for the top quality self-locking fastener that fits your need best.

ELASTIC STOP NUT CORPORATION OF AMERICA

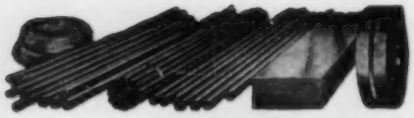
ESNA

ROLLPIN TRADEMARK

Elastic Stop Nut Corporation of America
Dept. N58-62, 2330 Vauxhall Road, Union, N. J.
Please send the following free fastening information:

☐ ELASTIC STOP nut bulletin ☐ Here is a drawing of our product. What self-locking fastener would you suggest?

Name_____ Title_____
Firm_____
Street_____
City_____ Zone_____ State_____



BRIDGEPORT BRASS COMPANY

COPPER ALLOY BULLETIN

Bridgeport Brass Co. MILLS IN BRIDGEPORT, CONN. AND INDIANAPOLIS, IND.—IN CANADA: NORANDA COPPER AND BRASS LIMITED, MONTREAL

Bridgeport Technical Handbook

To Help Our Customers on Metal Problems

Mass production of tiny but precise metal parts for electronic equipment calls for exacting specifications in brass and copper mill products. The Bridgeport "Technical Handbook" is designed as a ready-reference for product engineers and those responsible for purchasing and fabricating copper and copper-base alloys.

Bridgeport Brass Company recognizes the importance of supplying metal of uniform high-quality for automatic operations. Close cooperation between the fabricator and our technical service department will quickly help with materials to answer performance requirements, cut wasted time and prevent excessive spoilage.

Simplifies Alloy Selection

The Bridgeport "Technical Handbook" is divided into logical, easily read sections covering both general information and specific engineering data.

The first section discusses the numerous coppers and copper-base alloys, their compositions, physical and mechanical properties and their uses. It covers in non-technical language such subjects as the copper-zinc alloy system; the effects of additional elements such as lead, tin, aluminum, silicon, manganese, iron, nickel and arsenic on coppers; and the effects of annealing on physical properties. Temper or degree of hardness for sheet, rod, wire and tubing is explained. The causes and prevention of stress corrosion, cracking and hot breaks are discussed.

In addition, the "Technical Handbook" contains information on the importance of the microstructure of rolled and annealed brasses, graphically illustrated by micrographs and curves.

Mill Product Shapes

The following three sections are devoted to mill products—strip and sheet, rod and wire, and tubing. They are further broken down into groups such as Brass and Copper Strip for Drawing, Spinning and Stamping; Rods for Screw Machine Operation; Wire and Rod for Cold Heading; Rods for Hot Forging; Tubing for Fabrication; and many others.

Each classification lists not only the alloys and their applications, but gives a table of Composition, Mechanical Properties, Physical Constants, Fabrication Properties, as well as the latest specification numbers. By referring to these tables, the purchasing agent and the design engineer can see at a glance the alloys available and their comparative properties. This simplifies alloy selection, saves time and effort.

Hints on Metalworking

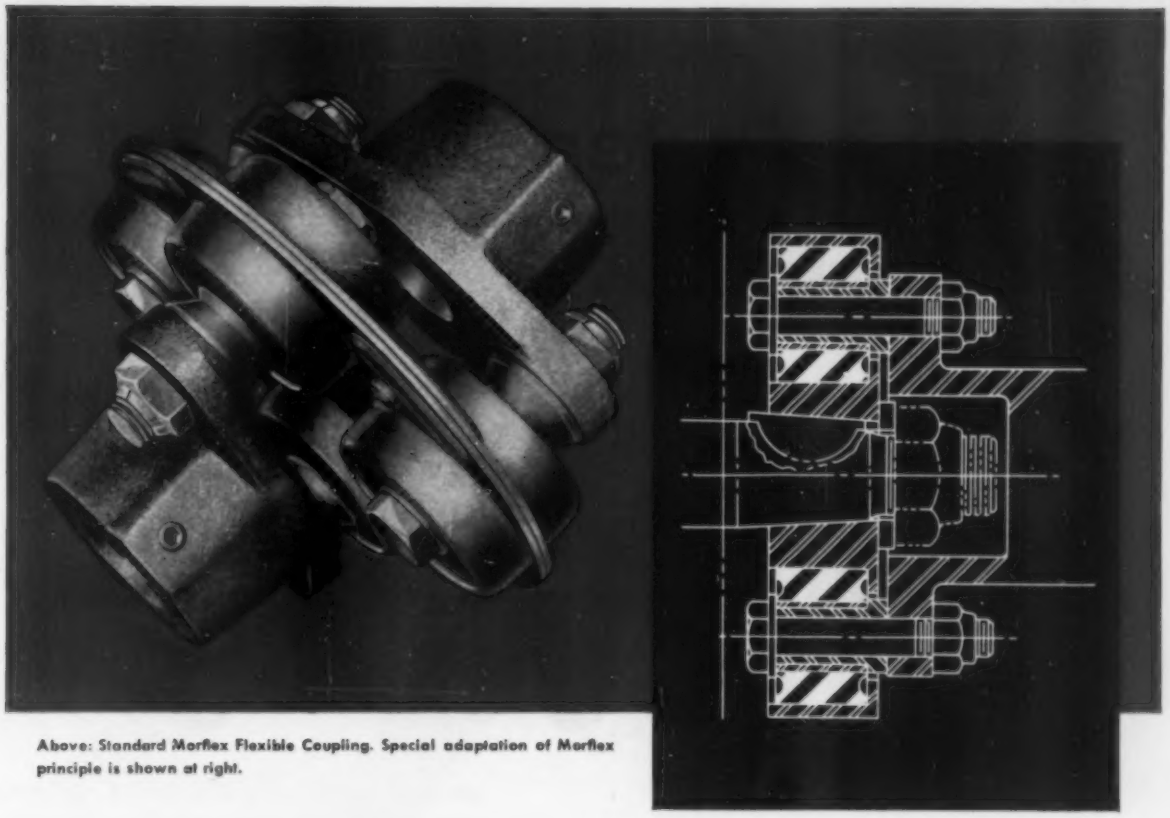
The handbook contains a brief but authoritative outline of procedures for working copper-base alloys. There are many diagrams and tables relating to machining, the tools to be used and recommended coolants. Data on Milling, reaming, chasing and sawing are given in concise tabular form with suggested procedures for the different alloys discussed. There are also full sections on drawing and drawing lubricants, annealing, cold heading, soldering, cleaning and dip coloring.

Useful Appendix

To complete the Handbook, almost thirty pages of informative tables are included as an Appendix. These tables cover equivalent weights, temperature conversions, metal melting points, length measurement conversions, and weights of flat products, circles, rod, round wire and copper tubes.

How to Get Your Copy

The Bridgeport "Technical Handbook" is a reliable guide to many problems and situations met by purchasing agents, design engineers and production superintendents in every-day work with copper-base alloys. Your copy will be quickly mailed upon request on company letterhead. And if you are confronted with metal problems not completely answered in the Handbook, do not hesitate to contact our nearest branch office for assistance as well as for your metal requirements. (1593)



Above: Standard Morflex Flexible Coupling. Special adaptation of Morflex principle is shown at right.

Let Morse solve your coupling problems--like this

In a recent power transmission problem faced by a transportation company, a 3-cylinder air compressor had to be driven from a 180-hp diesel through a gear transmission. To connect the driving shaft, a 20-horsepower coupling was needed. The problem was that the coupling diameter was limited to 4½", and the length to 1¼".

This coupling had to isolate vibration and absorb shock loading, as well as compensate for misalignment and resist oil.

Extreme space limitations called for a special treatment in the application.

A Morse representative was called upon to solve the problem. His study showed the need for an adaptation of the Morflex principle. He promptly designed the unit and was able to offer a coupling to suit the very need—with the added bonuses of noise elimination, prolonged bearing life, longer service life and elimination of maintenance.

The quick result was another successful solution embodying the exclusive Morflex principle of elastic deflection of pre-loaded Neoprene biscuits. (We are called upon to apply this principle daily in the solutions of both ordinary and unusual coupling problems.)

You can get results as remarkable as those outlined above. Put your design problems before a Morse representative to solve for you. He'll be glad to offer consultation services on any application of Morse power transmission products you may have in mind. Write for information today.

MORSE CHAIN CO.
7601 Central Ave.
Detroit 10, Mich.

MORSE
MECHANICAL POWER TRANSMISSION PRODUCTS

FOR 24 REASONS, MASTERS OF MECHANICAL POWER TRANSMISSION SINCE 1893

1 STANDARD ROLLER CHAINS
2 HIGH-ENDURANCE ROLLER CHAINS
3 SPRING-LOCK ROLLER CHAINS
4 ROLLER CHAIN SPROCKETS
5 TAPER-LOCK SPROCKETS
6 DOUBLE-PITCH ROLLER CHAIN DRIVES
7 CABLE CHAIN
8 ATTACHMENT CHAINS
9 SILENT CHAINS
10 SILENT CHAIN SPROCKETS
11 HY-VO DRIVES
12 AUTOMOTIVE TIMING CHAIN DRIVES
13 FLEXIBLE ROLLER CHAIN COUPLINGS
14 FLEXIBLE SILENT CHAIN COUPLINGS
15 MORFLEX COUPLINGS
16 MORFLEX RADIAL COUPLINGS
17 MORFLEX & RADIAL DRIVESHAFTS
18 MARINE COUPLINGS
19 OVER-RUNNING CLUTCHES
20 OVER-CENTER CLUTCHES
21 PULLMORE CLUTCHES
22 TORQUE LIMITER
23 CENTRIFUGAL CLUTCHES
24 VARIABLE SPEED CONTROLS

This fastener works through thick and thin!

Spring-Lock—the easy-to-use removable fastener for modern designs—works whether panel thicknesses run over or under specifications! Spring wire deflects automatically to handle greater or lesser thicknesses. Spring-Lock's design flexibility makes it more than a fastener: it can be adapted as a shelf support, door strike, knob or any similar panel-mounted device. Many standard shapes and sizes of Simmons Spring-Locks are available from stock.

SIMMONS FASTENER CORPORATION

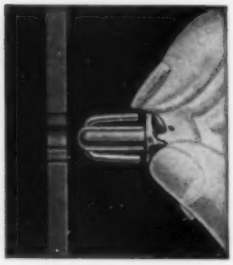
1751 North Broadway, Albany 1, New York

Simmons

QUICK-LOCK
SPRING-LOCK
ROTO-LOCK
LINK-LOCK
DUAL-LOCK

JUST OUT!
NEW 36-PAGE CATALOG WITH APPLICATIONS
SEND FOR IT!

HERE'S HOW SPRING-LOCK WORKS



1. *Insert fastener.*

2. *Half-turn locks it in place.*

With production costs on the uptrend, you can figure on Spring-Lock as an assembly time and money-saver, because:

- **Installation is BLIND**
- **Installation is EASY: no special tools are needed**
- **Installation is QUICK: a half-turn locks it in place**
- **Installation is SECURE: the *spring* steel *locks* the fastener, resists vibration**

Send for details and samples, or write us about *your* fastening problem.

A complete line of

PowerGrip "TIMING" Belts

by U.S. Rubber

U.S. PowerGrip TIMING Belt with its positive engagement takes hold of the pulley grooves with perfect fit, perfect grip. Slippage or power loss can't happen.

FAST DELIVERY
COMPLETE ENGINEERING SERVICE
FULL STOCKS

As an industrial designer, you have often met problems involving the transmission of mechanical power: hand tools, lathes, drill presses, saws, electric typewriters are some examples. In such cases, you had to go along with the limitations imposed by V-belts, chain drives or gears. But now the U. S. PowerGrip TIMING® Belt, developed and perfected and thoroughly proved for over six years by United States Rubber Company, gives you entirely new freedom, new scope, new horizons of design. MOREOVER, the "U. S." network of distribution centers, sales offices and TIMING Belt Distributors permits fast supply plus complete engineering service.

EVER WISH YOU COULD USE SMALLER PULLEYS? You can with the U. S. PowerGrip TIMING Belt... *no slippage, no take-up.* This permits very short centers and high ratios. Light weight of PowerGrip permits high speeds.

DO LUBRICATING AND HOUSING DEVICES GET IN YOUR WAY? The absence of metal-to-metal contact in the U.S. PowerGrip TIMING Belt makes lubricants and oil-retaining housings unnecessary. Less cost, less weight.

DO HIGH BELT SPEEDS SLOW YOU DOWN? The U. S. TIMING Belt can easily handle speeds up to 16,000 F.P.M. Light weight keeps centrifugal force way down. Yet, because it cannot slip, U. S. PowerGrip TIMING Belt can be operated at speeds so slow as to be imperceptible.

WHAT ABOUT HORSEPOWER? H.P. Range is 1/100 to 300 or more. Stock drives run to 50 H.P., but wider belts and pulleys can be made on order in standard lengths and diameters.

IS EFFICIENCY ALL IT COULD BE? Because there are no friction-creating joints, no slippage loss, no lubricated drag—minimum heat generation and minimum bearing loads, U. S. PowerGrip TIMING Belts have an efficiency of close to 100%.

Write to any of the 26 District Sales Offices or the address below. Ask for free catalog.

"U. S." Research perfects it..."U. S." Production builds it... U. S. Industry depends on it

UNITED STATES RUBBER COMPANY
MECHANICAL GOODS DIVISION · ROCKEFELLER CENTER, NEW YORK 20, N. Y.

Hose • Belting • Expansion Joints • Rubber-to-metal Products • Oil Field Specialties • Plastic Pipe and Fittings • Grinding Wheels • Packings • Tapes Molded and Extruded Rubber and Plastic Products • Protective Linings and Coatings • Conductive Rubber • Adhesives • Roll Coverings • Mats and Matting

It's a BIG idea...and it WORKS...

THE IDEA OF STANDARDIZED GEARS

— of the highest quality, completely interchangeable — was originated by BOSTON Gear seventy-five years ago.

IT HAD TO BE A BIG IDEA

To make the idea work, the gears had to be AVAILABLE quickly, to any buyer — anywhere. Distribution facilities had to be BIG as all industry, expanding with it. That's why BOSTON Gear Products are sold through Industrial Distributors.

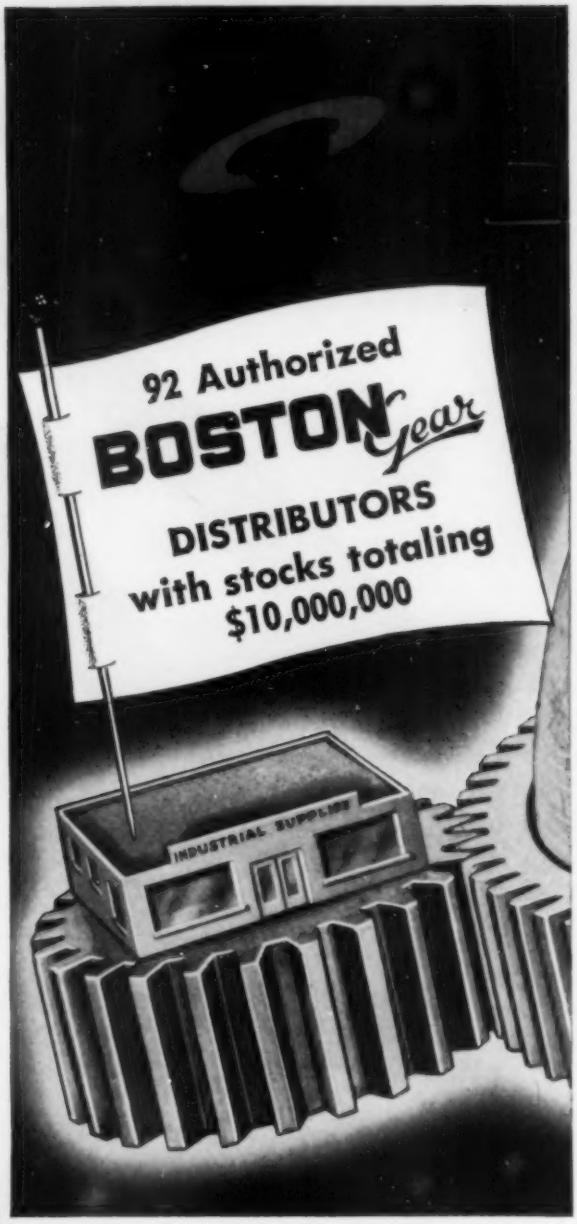
YOUR BOSTON Gear DISTRIBUTOR

"brings the BOSTON Gear plant to you" — the benefits of a 75-year experience — the engineering counsel of transmission planning experts — full stocks of BOSTON Gear Products — and FACTORY PRICES!

LET THIS IDEA WORK FOR YOU

To more than 250,000 cost-wise buyers, BOSTON Gear now means *best buy* for top quality, lasting economy, and trouble-saving convenience. Compare — you'll see why it will pay you to "Design around BOSTON Gear" . . . to specify BOSTON Gear for any maintenance need.

Call your nearby BOSTON Gear DISTRIBUTOR
He has a factory-trained specialist ready to help you, Boston Gear Works, 71 Hayward St., Quincy 71, Mass.



BOSTON Gear WORKS 75th YEAR OF SERVICE 1879—1954

BOSTON Gear®

STOCK GEARS — 2000 TYPES and SIZES

SPROCKETS and CHAIN

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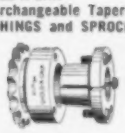

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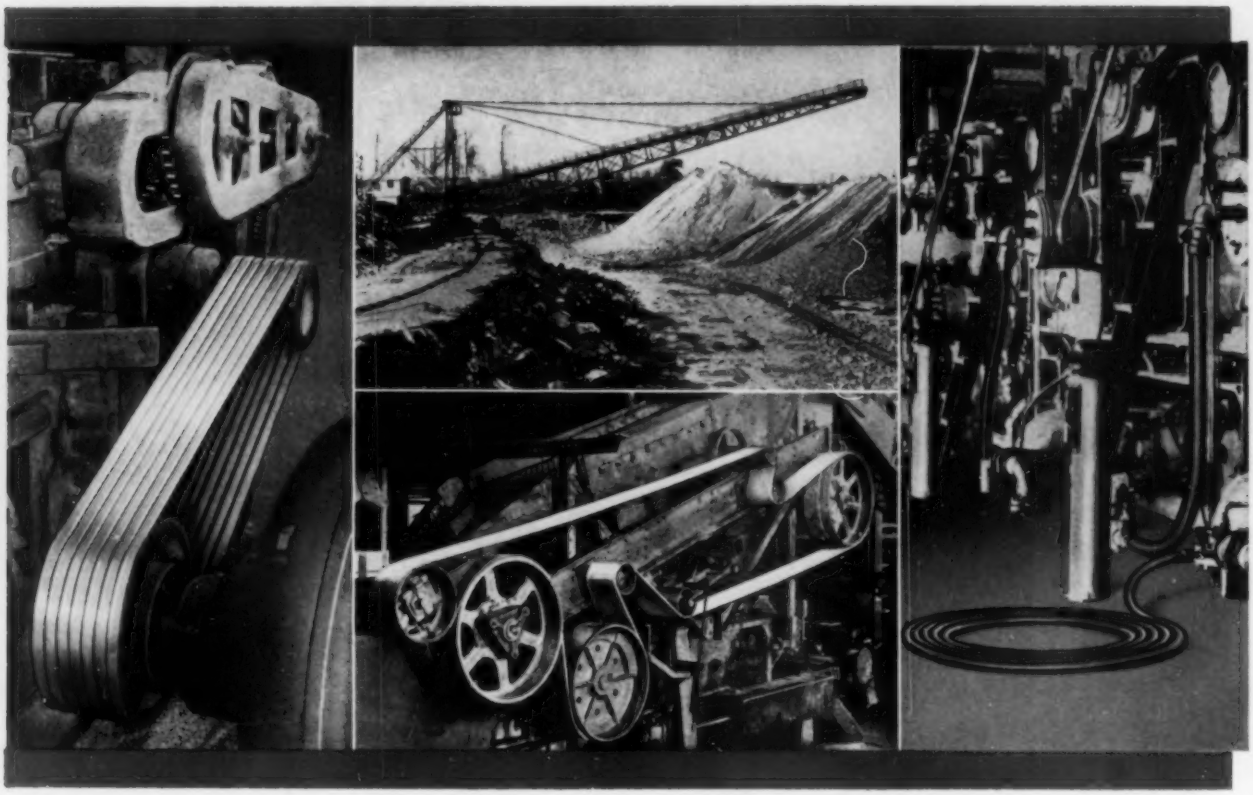

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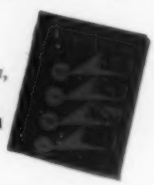
There is also an R/M engineered conveyor belt for every application, such as the traveling stacker conveyor pictured above . . . for heavier quarry and mining operations . . . for lighter portable and package conveyors. R/M makes hose for hundreds of uses—from ¼" to sizes large enough to crawl through. Typically, the Homoflex Paper Machine Hose shown was designed for strength, extreme flexibility and light weight, with a soft rubber nozzle to avoid injury to costly machine rolls. R/M also mass produces engineered molded rubber parts of natural or synthetic rubber, nylon or silicone, in any size or shape to meet your specifications. Let an R/M rubber specialist work with you on your next design project or to improve present performance.



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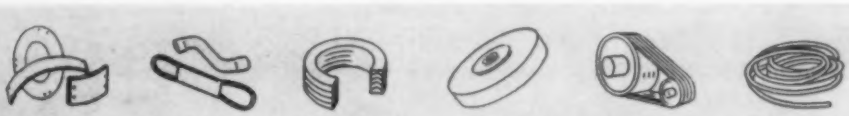

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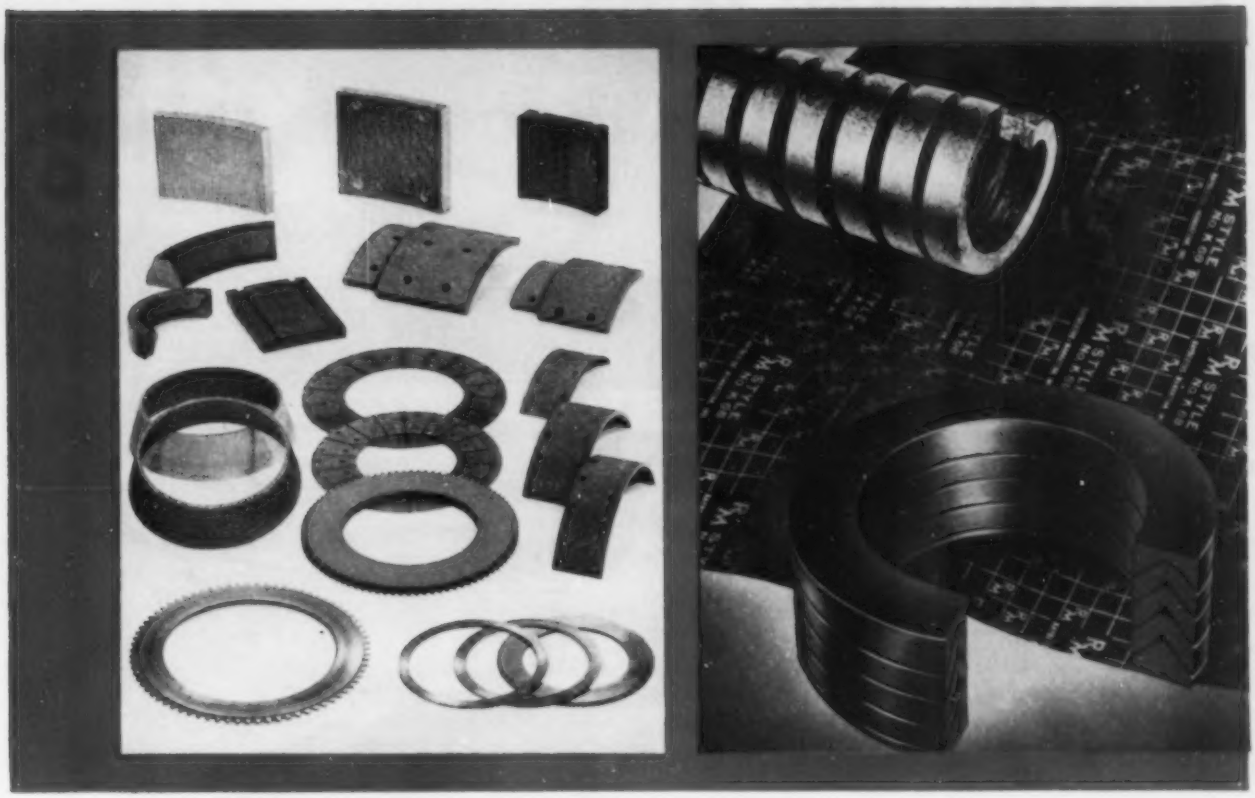

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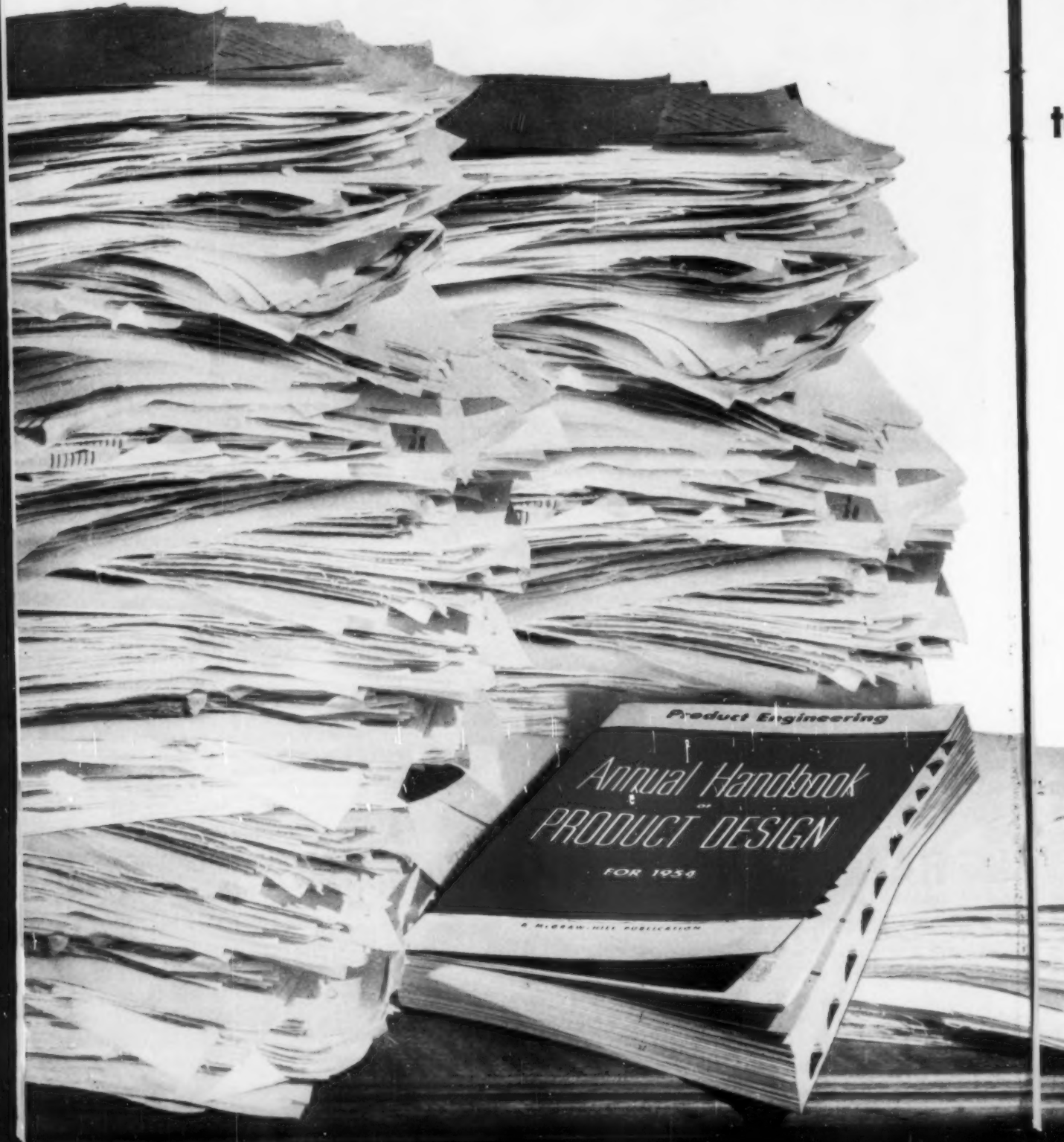


....THIS

will be your most wanted, hardest-used guide to this year's top developments in design engineering

When we mailed the Annual HANDBOOK of Product Design for 1954 last November, we hoped it would prove to be the most valued, long-useful issue of a magazine ever edited for design engineers like you. And in more than 3,000 letters, you have told us that this second of our Annual HANDBOOK issues *is* of outstanding and permanent value to you. These letters constitute, so far as we know, a record reader response to an issue of a business magazine.

Far more important than making records, however, is the value of these letters to us in making sure that the 1955 HANDBOOK is even closer to what you want in an issue of *Product Engineering* that earns a permanent place on your desk, as a continuing reference source to design-engineering's top ideas and facts on better design.

We're working, now, to make the 1955 HANDBOOK the "best yet." New ideas and features are going into it . . . but none of the tried and proved ones you like are being discarded for the sake of "something new." Once again, you'll find the HANDBOOK conveniently divided into 10 cohesive, informative sections, each thumb-indexed for fast reference. Once again, too, the HANDBOOK will have a sewn, "lie-flat" binding and special, extra-durable covers. An important feature, too, will be a complete editorial index to both the 1953 and 1954 HANDBOOKS so that you can refer to *all three* issues easily and quickly.

There will be more information about the 1955 HANDBOOK for you in these pages soon. And in the meantime, be sure we're working every day to make this issue the strongest evidence yet of why, for you and 27,500 other *Product Engineering* subscribers, your investment in this magazine is your greatest value in new facts and ideas on better product design. Publishing date for the 1955 HANDBOOK: October, 1954.

* *Subject to ABC audit*

Product Engineering

THE McGRAW-HILL MAGAZINE OF DESIGN ENGINEERING
McGRAW-HILL BUILDING, NEW YORK 36, N.Y.

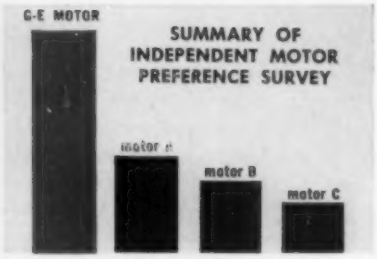
ABP ABC

Designer's

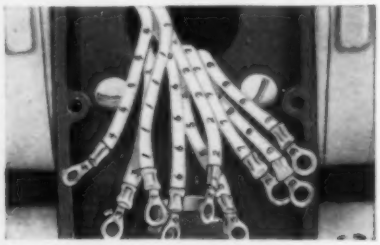
Three good reasons for designing new TRI 55 CLAD motors into your machines

MODERNIZE YOUR EQUIPMENT with all-new General Electric Tri/Clad* '55' motors. A complete line assures you of getting the right electrical drive for your machine. Ratings in new NEMA 182 and 184 frames now available . . . entire line to 30 hp available soon. Check coupon for more information on Tri/Clad '55' dripproof, enclosed, and gear-motors.

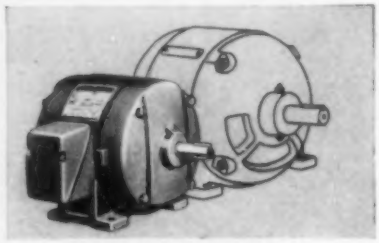
*Registered trade-mark of General Electric Co.



1. BUYER PREFERENCE. You take advantage of a 2 to 1 preference for the motors on your equipment when you use G-E motors. Buyers also like the G-E small motor service station plan (Bulletin GEC-972).



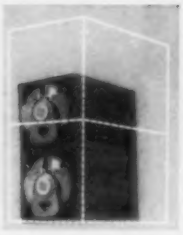
2. EASIER INSTALLATION. Perma-numbered leads are always easily read even when taped or clipped. Roomier conduit box has plenty of knuckle room. Bolts go in easily, quickly.



3. MORE POWER PER POUND. Lighter, smaller Tri/Clad "55" motor—in new NEMA frame sizes and ratings—reduces waste space, saves weight, lowers your handling, shipping costs.

GENERAL ELECTRIC

Digest GE PRODUCT HIGHLIGHTS

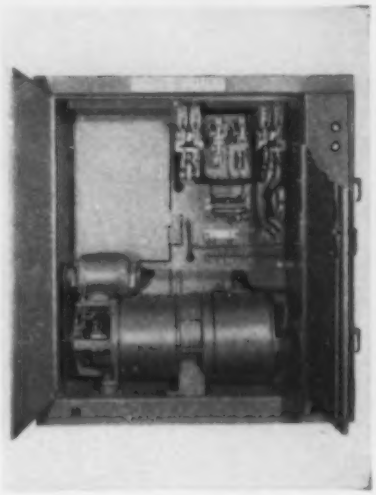


Specify G-E fhp motors to save space, material, shipping costs

G-E fhp motors give you up to 50 per cent savings in motor weight—cut down your shipping costs. Lighter weight means you can use structurally lighter mountings, save on mounting material. Some ratings save you as much as 40 per cent in space required for stocking motors, permit better use of valuable warehouse space and reduce material-handling costs. Your assembly-line people will find G-E fhp motors easier to handle, far faster to install. There's less "assembly fatigue" caused by handling heavy components. See Bulletin GEA-5567.

G.E. announces new Speed Variator designed to meet JIC standards

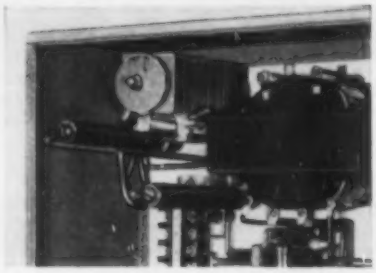
This new G-E Speed Variator is a packaged all-electric adjustable-voltage drive operating from a-c power, for use where conformity to JIC standards is required. It gives you highly efficient operation over wide speed ranges from 8 to 1, up to 50 to 1. Components are: a power unit in attractive cabinet, containing motor-generator set and all necessary control; d-c motor; operator's remote control station. New JIC features include: positive-pressure ventilating system which keeps out dust; metal diagram pocket on inside of enclosure; doors mechanically interlocked with disconnect switch for safety; rigid all-steel enclosure; color-coded wiring; a-c control isolated from d-c control; a fusible disconnect switch to isolate unit from power source; and lockable disconnect switch on door. Write for Bulletin GEA-6000.



Get high repetitive accuracy with G-E electronic timers

Precise timing, adjustable from 0.06 to 120 seconds for important machine functions, is yours with G-E timers. Repetitive accuracy is within ±2% of dial setting, independent of normal temperature changes. Can be used for immediate or delayed start. Timing dial may be remotely mounted for easy adjustment. Ask for Bulletin GEA-5255.

Metallic rectifiers help make machine tools more productive



Metallic rectifiers, such as the selenium stack (right), used to supply d-c power for magnetic clutches and brakes, have helped to increase the productivity of this lathe and other machine tools. Many control circuits use these rectifiers to power d-c relays. Let G-E selenium, copper-oxide, and germanium rectifiers help you in designing more productive machine tools. Check coupon for bulletins.

General Electric Co., Apparatus Sales Division, Section C668 -114, Schenectady 5, N. Y.

Please send me the following bulletins: √ for reference ✕ for immediate project

- ☐ GEA-6012 Tri/Clad '55' Enclosed Motors
- ☐ GEA-6027 Tri/Clad '55' Gearmotors
- ☐ GEA-6013 Tri/Clad '55' Dripproof Motors
- ☐ GEC-972 Small-motor Service Station Plan
- ☐ GEA-6000 JIC Speed Variator
- ☐ GEA-5567 Fractional Horsepower Motors
- ☐ GEA-5699 Copper-oxide Rectifier Stacks
- ☐ GET-2350 Selenium Rectifier Manual
- ☐ GEA-5773 Industrial Germanium Rectifiers
- ☐ GEA-5255 Electronic Timers

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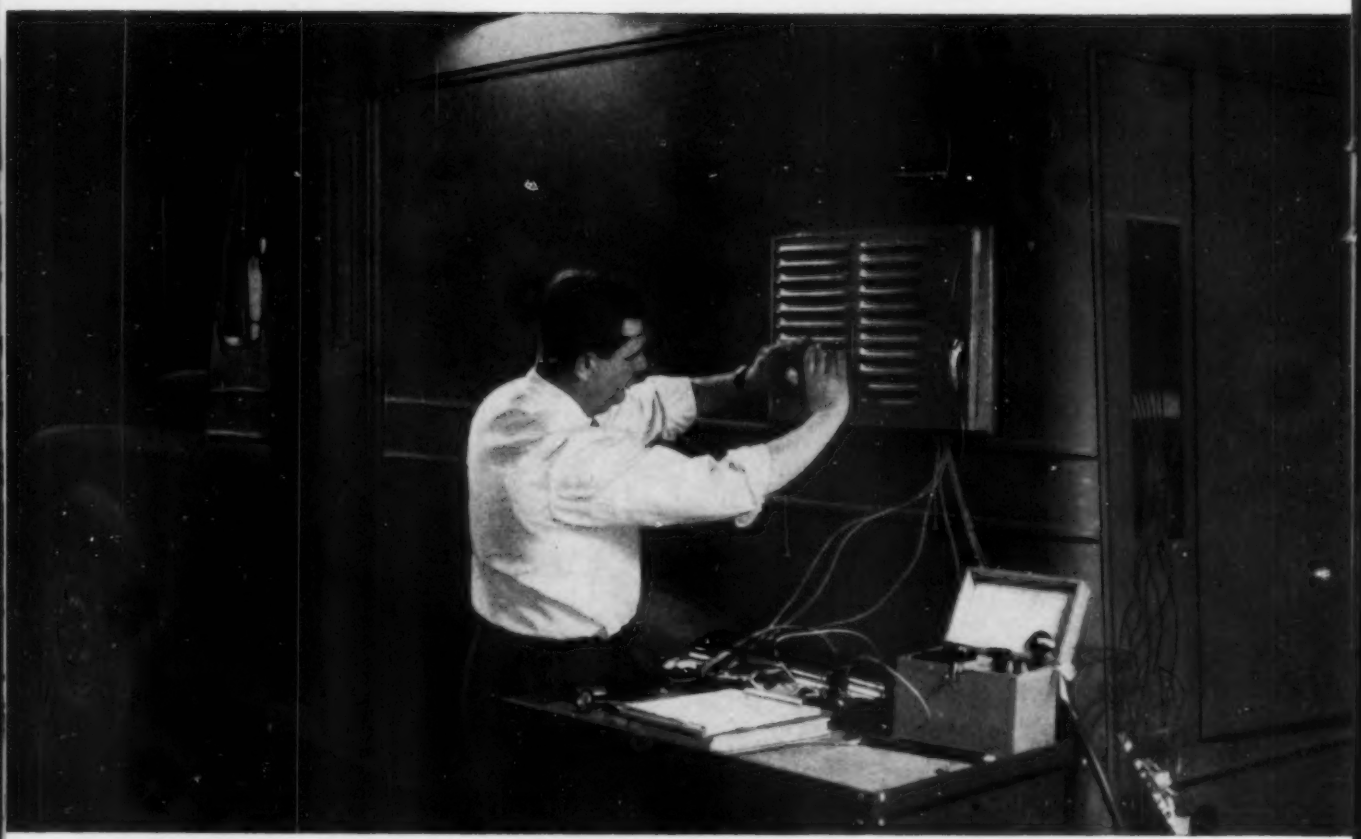
City _____ State _____

This Allen Cooler truck went right into our lab and proved . . .

Why it pays to ask for



G-E ENGINEERING solved a complex truck refrigeration problem for Allen Cooler. The General Electric system provides uniform temperature when operating off the engine drive or on 115-volt AC plug-in during off hours. System was created by modifying standard G-E components, including an alternator, a rectifier, and two fractional-hp motors, and adding a regulator.

1 PROBLEM PRESENTED to G.E. by Allen Cooler design engineers called for flexible 24-hour truck refrigeration, maximum storage capacity, and minimum cost.

2 RIGHT INTO G-E LAB went this home delivery truck. Laboratory study indicated design requirements, helped cut time needed to come up with final electrical system.

G-E motor application help

G-E engineers design electrical system to provide low-cost truck refrigeration during deliveries . . . plus overnight plug-in service

If you have a difficult motor application problem, you'll find it pays to take advantage of the technical skills and the resourceful engineering of General Electric's Specialty Component Motor Department. Here's how Allen Cooler profited:

Allen Cooler design engineers wanted this: an electrical system for refrigerating milk delivery trucks which would operate at full cooling capacity at engine idling speed. An additional requirement was that the system also operate on 115-volt AC during off hours, thus providing 24-hour service. However operated, the system should maintain temperatures between 35 and 40 degrees at all times.

G-E motor engineers went to work on these specifications. They devised a packaged electrical system incorporating an alternator, a compressor-drive motor, an evaporator motor, a regulator, and a rectifier. Made up of these skillfully integrated components, the compact system provides reliable cooling with maximum truck-storage capacity.

Working closely with the Allen Cooler engineers, General Electric engineers installed the packaged system in a dairy truck and tested it under actual operating conditions. The amazing performance: during 6000 miles of hot weather service, there was not a single operational complaint.

Next time you have a tough motor application problem, bring it to General Electric. You'll be taking advantage of engineering skills unmatched anywhere. To arrange for this service, contact your nearby G-E Apparatus Sales Office. For more information, write General Electric Company, Section 704-27, Schenectady 5, New York.

Progress is our most important product

GENERAL ELECTRIC

3 **ACTUAL CONDITIONS** of operation were simulated. In this cell, temperature control accuracy was checked.

4 **INSTALLATION OF ALTERNATOR** under truck's hood. Unit must withstand heat, be compact, yet provide sufficient capacity.

5 **FINAL UNIT** uses minimum space, maintains even temperatures during deliveries, permits plug-in service.

Extra corrosion resistance— Type 316 stainless is now available in MicroRold®!

Cut your job costs by ordering *Washington Steel MicroRold* Type 316 stainless steel. Remember, job costs are figured on a square foot basis — while material is bought by weight. Why pay a premium for stainless surface area by receiving material on the heavy side of the gauge you order? Special equipment at Washington Steel assures accurate "thinness control" on MicroRold . . . and you can specify that your MicroRold Type 316 be rolled to the light side of the gauge range. You'll save money!

MicroRold Type 316 Stainless is available as follows:

SHEETS

Max. 36" wide No. 4 and 7 Finish .012 to .109
Max. 36" wide 2B and 2D Finish .005 to .078
Max. 36" wide Physicals—(average)

Condition	Annealed
Ultimate Tensile Strength P.S.I.	85,000
Yield Strength (.2% set) P.S.I.	40,000
Elongation in 2 inches, %	55
Rockwell Hardness	B 75-80
Scaling Temperature, °F	1700
Grain Structure	Austenitic-Nonmagnetic

STRIP

.005 to .078, in No. 1 and No. 2 Finish
.0015 to .009 (Veri-Thin), up to 23 15/16" wide, Bright Annealed

Ask your steel warehouse distributor about MicroRold Type 316 Stainless—widely used throughout the chemical industry and wherever applications must resist salt spray, damaging industrial fumes, acid salts and reducing acids. It will pay you to get full details now!

Washington Steel CORPORATION
WASHINGTON, PENNSYLVANIA

Perspectives

DESIGN AND DEVELOPMENT

AUTO MAKERS IN PARTS BUSINESS

Some recent developments in the industry may have left the impression that auto manufacturers are leaning towards complete self-sufficiency by getting rid of the parts suppliers and going into business for themselves. Examples: Chrysler Corporation's buying out the body-building facilities of Briggs Mfg. Co.; and, its decision to build its own power steering units rather than get them from Gemmer Mfg. Company. As the DeSoto uses the Gemmer unit, chances are that the new Chrysler unit will be used here as well. By the same move, suppliers of power steering for both Dodge and Plymouth may be displaced in the future. Lincoln will soon start to build its own automatic transmission, rather than buy the Hydra-Matics from General Motors, and GM too, has indicated that they will get into the spare parts business. Similarly, it appears that other suppliers might get caught in the squeeze simply because they cannot compete costwise with the larger manufacturers.

DON'T SELL SUPPLIERS SHORT

But despite the signs, the auto makers are not abandoning the outside suppliers just like that—for several reasons. First, the average auto contains about 8,000 components. A single automobile manufacturer would find it difficult to produce each one, and certainly none would go to the extremes Henry Ford once did in attempting to make his empire entirely self-sufficient. Some auto makers, Chevrolet for instance, like to have at least two, preferably three suppliers for every item it uses. A spokesman for another firm said, "We are watching suppliers more closely now. If they are in competition with each other, they can, in most cases, furnish parts at a lower cost than we can."

Secondly, many of the automotive advancements can be traced directly to the suppliers. By going to an outside supplier, the auto manufacturer gains the experience of the suppliers' engineers and production men. But when the manufacturer drops a supplier and goes into the parts business for himself, he must add to the payroll, and finance all the engineering and research formerly done by the supplier. A good case here is the production of the plastic-bodied Chevrolet Corvette, which was only possible through the engineering research on the part of the plastics industry. Members of the reinforced plastics field claim that their industrial development was advanced five years by the success of this body program.

SUPPLIERS DROP BY THE WAYSIDE

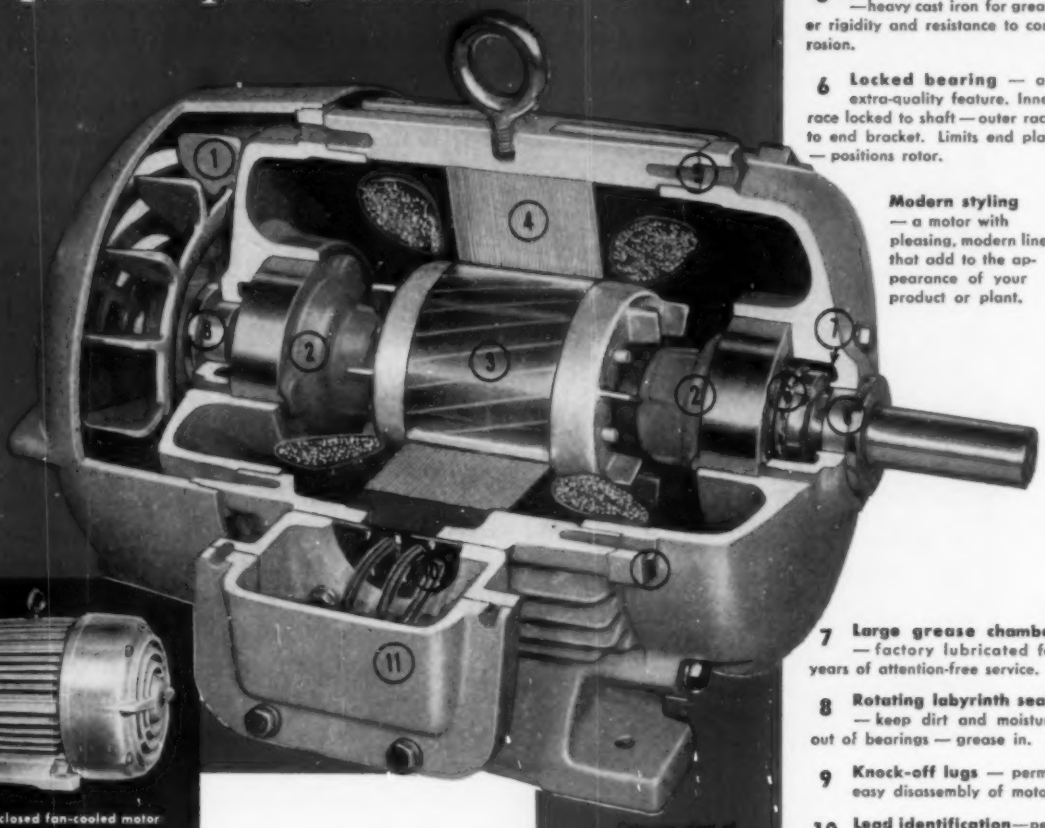
The mortality rate among suppliers will remain the same, of course, and may go up. The reason being that the many suppliers who cropped up in the fat post-World War II have not been exposed to the hot competition of the automobile industry during ordinary market conditions. With the present buyers' market in the auto industry, the manufacturers have been

(Continued on page 125)

Here's the inside story of

the NEW L.A. *Line*

...your BEST enclosed and explosion-proof motor BUY



1 Fan — efficient, non-sparking fan. New aerodynamic design for more effective cooling.

2 Inner bearing cartridges — lock bearings to end bracket and form explosion-quenching seal along shaft.

3 Indestructable cast-aluminum rotor—dynamically balanced with fan for smooth, quiet operation.

4 Stator — prewound stator core utilizes Formvar wire insulated with a new Alkyd Asphalt Resin insulating varnish.

5 End bracket and housing —heavy cast iron for greater rigidity and resistance to corrosion.

6 Locked bearing — an extra-quality feature. Inner race locked to shaft — outer race to end bracket. Limits end play — positions rotor.

Modern styling — a motor with pleasing, modern lines that add to the appearance of your product or plant.

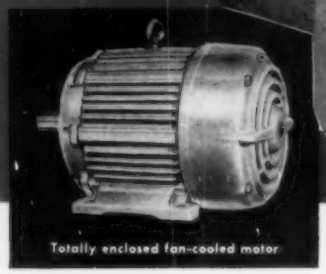
7 Large grease chamber — factory lubricated for years of attention-free service.

8 Rotating labyrinth seals — keep dirt and moisture out of bearings — grease in.

9 Knock-off lugs — permit easy disassembly of motor.

10 Lead identification—permanent, positive lead identification spacer in conduit box.

11 New split conduit box — rugged cast-iron conduit box diagonally split for easy connection.



Totally enclosed fan-cooled motor

Cutaway view of explosion-proof motor

This is the completely new L.A. totally enclosed fan-cooled and explosion-proof motor. Every feature in this new line is designed for easier installation, longer service life, less maintenance and attention. You get the full benefit of the new NEMA standards in a smaller, more functional, completely modern design.

Your nearby Louis Allis Sales Engineer can show you all the reasons why these motors perform better and longer on your tough jobs — why they give you maximum resistance to corrosion wherever you need this extra protection. Call him today.

THE LOUIS ALLIS CO.
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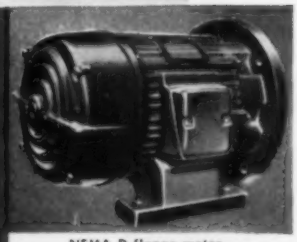
LA-103

Vertical NEMA D-flange motor

NEMA C-flange motor



NEMA D-flange motor

We specialize in SPECIAL MOTORS — *and* PROMPT DELIVERY, TOO

There's a Louis Allis special motor for your toughest application. Whatever electrical or mechanical modifications you need, check first with Louis Allis.

forced into cost-cutting programs, and the suppliers are the first to feel the pressure. Also, some of the single-item suppliers will run the risk of being "obsoleted" out of business by engineering advances within the industry. The gas turbine, while a long way from practical application, is an extreme case.

DIVERSIFICATION

Many suppliers, knowing that times might not always be rosey, have insured themselves against the possibility of not being able to meet competition, and diversified. They have already learned that strikes, a declining auto market, national emergencies, and other production-stoppers have a fatal effect. Movement into other fields is an attempt to level out these profit peaks and valleys. Borg-Warner is a good example. In 1953 its automotive products represented only 58 percent of the total volume. Aviation products accounted for 10 percent, farm equipment components another 7, defense work 21 percent, and the balance made up in refrigerators, home freezers, oil heating furnaces, and aluminum foil blanket insulation. To add one more to the collection, B-W recently bought out a manufacturer of machine knives, files, saws, and tools.

Motor Wheel Corp., a major supplier of auto wheels, branched out as far back as 1928 by producing oil water heaters and furnaces; in 1938, agriculture and industrial equipment; in 1949 gas space heaters; and in 1953, incinerators and tractor wheels were added. Another company, L. A. Young Spring & Wire Corp., manufacturers of auto seat back springs and garnish mouldings, bought out a manufacturer of power tail gates, farm hoists, and steel dump bodies. Previous to this, he moved into the wire coat hanger and inner-spring mattress market.

SUPPLIERS' POSITION STRONG

The suppliers are still the strong part of auto industry, as testified by Chrysler's nearly 11,000 vendors. The financial reports of the auto companies verify this with figures giving the proportionate amount of each sales dollar paid out for supplies and services. A concrete case cannot be established from these figures, for they include everything from the supplier of brooms for the janitor to the company supplying tires and radios. But it is significant that in all cases the proportionate amount has been rising steadily in recent years.

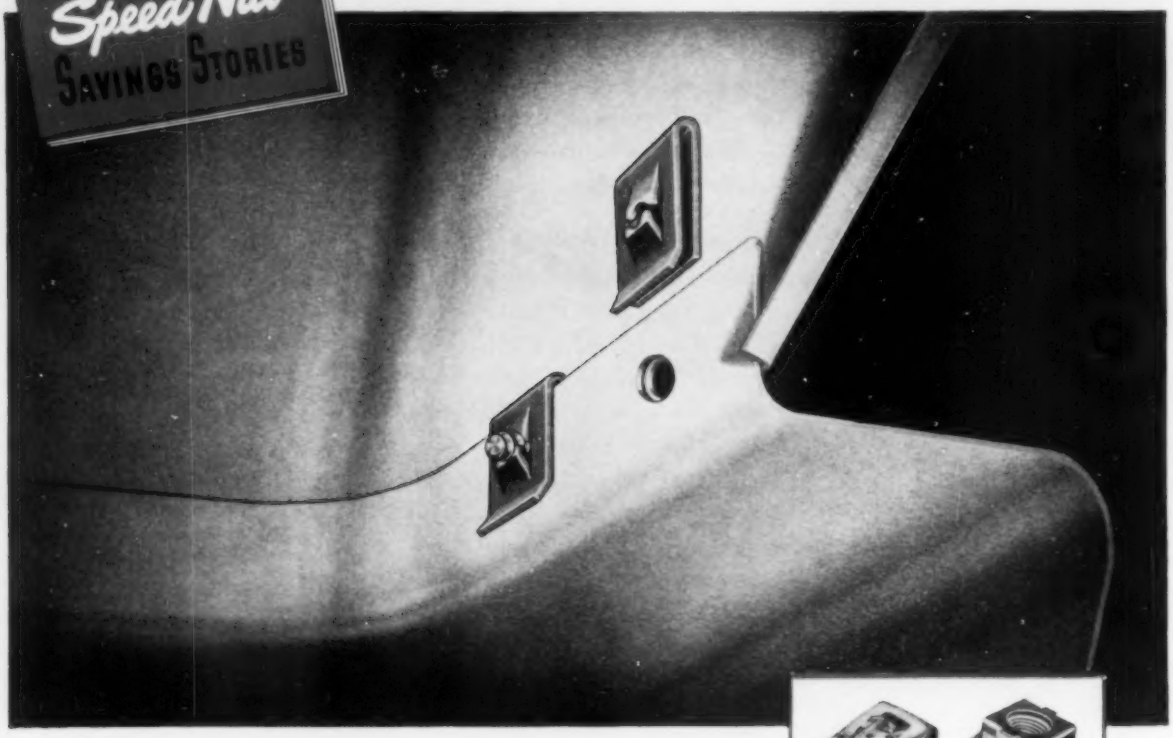
In 1950, General Motors paid out 46.75 percent of each net sales dollar to suppliers of parts and services. (In terms of passenger car and truck output, 1950 was the biggest year the auto industry ever experienced). In 1951, GM paid out 49.25 percent; in 1952 it dropped to 48.50 percent, but in 1953 jumped to 52.75 percent.

In 1950, Chrysler Corp. paid 62 percent of each sales dollar to suppliers; in 1951, it paid 67 percent; fell to 61 percent in 1952; and rose to 65.80 percent in 1953. For Studebaker Corp., the figure was about 71.5 percent in 1951; in 1952 it was about 73.30 percent; and in 1953, about 73.1 percent. Nash Motors Div. in 1950 paid out 57.80 percent; it was 59.70 percent in 1951; and 58.7 percent in 1952.

TINNERMAN ®

Speed Nut Savings Stories

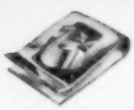
FASTEST THING IN FASTENINGS®



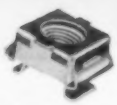
SPEED NUTS® give helping hand on "Yard Hand" assembly problems

The new Hiller Yard Hand is an excellent example of how an assembled product benefits from a Tinnerman Fastening Analysis Survey. This miniature garden tractor, capable of rugged service, is a product of the Hiller Engineering Corporation, Redwood City, California.

Standard "U" Type SPEED NUTS were recommended for assembling the hood to the yoke. SPEED GRIP Nut Retainers were specified for securing the yoke brace to main frame and for fastening saw table to hood. Both types of fasteners snap easily and quickly into place by hand, are self-retaining in screw- or bolt-receiving position, and are ideal for blind locations. Result: heavy duty, vibration-resistant attachments at a significant savings in assembly costs and materials handling! Let Tinnerman lend a helping hand on your fastening problems; ask your Tinnerman representative soon for complete details on the Fastening Analysis Service.



"U" TYPE SPEED NUT



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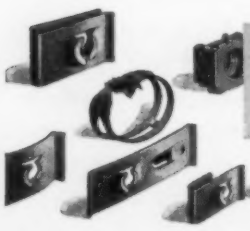

TINNERMAN Speed Nuts®

MORE THAN 8000 SHAPES AND SIZES

Standards Without Worth

IN SPITE OF ALL the standardization committees, associations and societies, engineering is still plagued with worthless so-called standards. Sheet thicknesses, wire diameters, drill sizes and screws are still being designated by meaningless, outmoded and inane numbers or letters.

Ingrown habit, mental inertia and childish conformance to tradition are the only excuses for still using the multiplicity of confusing gage numbers and letter sizes. It is now forgotten that they were born by manufacturers for commercial reasons, if any. Birmingham, Stubbs and Brown & Sharpe signify companies or groups that wanted their arbitrary "standards" used by industry.

There are many engineers who are quite "fed up" with designating sizes by means of arbitrary numbers. The situation has one amusing aspect. There is no law to compel an engineer to specify screw diameters, sheet thicknesses, or wire diameters by numbers. Nor is any one confused when thickness is given as so many thousanths of an inch. On the other hand, the eight different standards for sheets and wires are in themselves highly confusing.

If design engineers were to begin specifying sizes in decimals of an inch in place of gage numbers it might be possible to relegate the so-called standards to oblivion, where they belong. The next step would be to bring pressure to bear toward the establishment of sensible standards for sheets, wires and screws. These could easily be established without hardship to anyone, though there would probably be some loud but harmless squawks.

Although the still used but outmoded standards have some basis or other, it would be more logical to use a mathematical basis for the progression in thicknesses or diameters. And as to the use of arbitrary numbers or letters to express gages, it is rather childish to first establish a dimension and then designate it by an arbitrarily chosen numeral or letter.

It requires no explanation or reference table to understand that an eighth inch sheet thickness means a sheet 0.125 in. thick. Except for those who have memorized the tables, a 10 U. S. gage steel sheet thickness is meaningless. And its equivalent, 0.1379 in. is also unobtainable in practice. Steel sheets cannot be rolled that accurately.

Design engineers are in a powerful position to kill the use of artbitrary gage numbers. All they need do is simply stop using them. And if a vendor quotes gage numbers, simply drop him a note and politely request him to express what he means in decimals of an inch. In a relatively short time the omission of gage numbers and letters on drawings and bills of materials, and expressing the quantities in inch or metric units would obsolete the use of arbitrary gage designations.

George F. Zimmerschied

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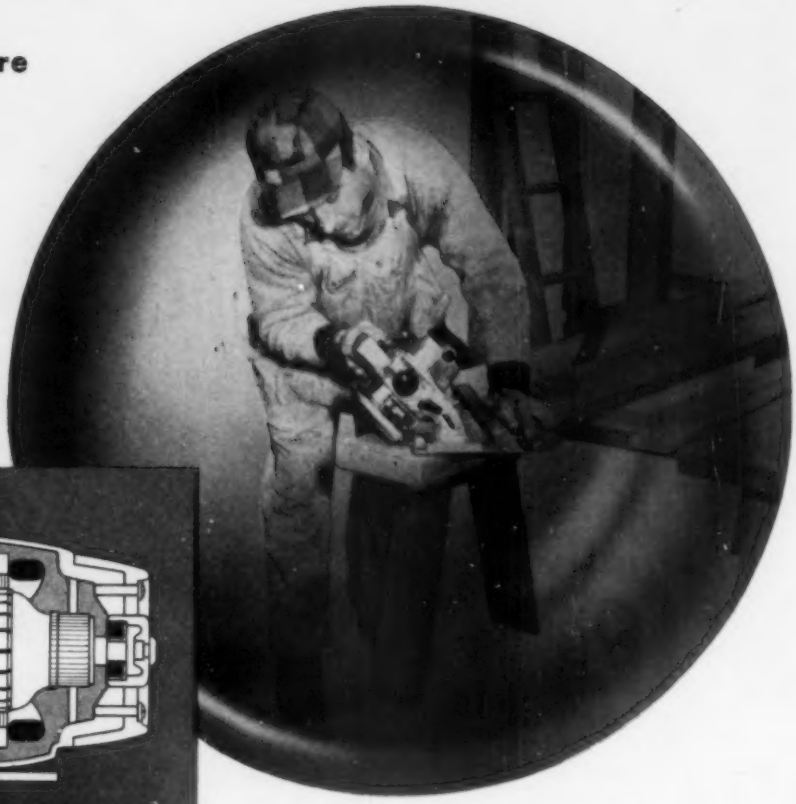

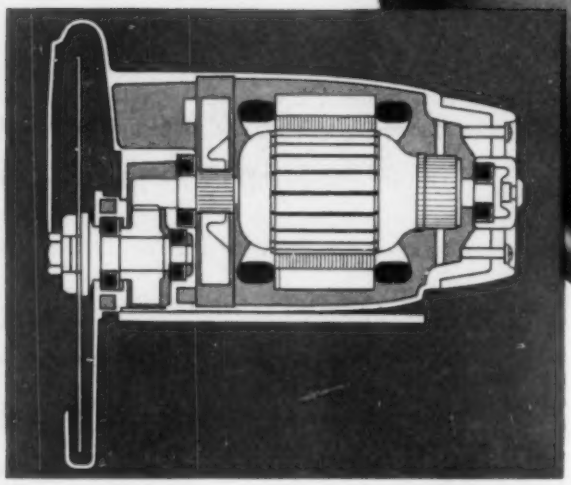

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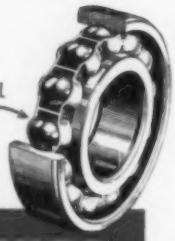

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ACRYLIC AIRCRAFT CANOPIES, such as this one being removed from forming chamber, are still among largest products fabricated by the vacuum forming technique.

Rohm & Haas Co. *Plastic Age Co.*

Formed Sheet Plastics—

A Fast Growing Field

EDWARD F. BACHNER, JR.
Vice-President, Campco Division,
Chicago Molded Products Corporation

PRINCIPAL ADVANTAGE in fabricating the various thermoplastic sheet materials is the flexibility of the many forming techniques. The manufacturer or fabricator can suit his production methods to his own requirements, all the way from the construction of molds to the final finishing operations. While scores of industries have successfully adopted these techniques, future possibilities are limited only by the ingenuity of the designer and production engineer.

FORMING STRUCTURAL SHAPES from sheet stock—long established in metal fabrication—is rapidly becoming an important factor in plastics fabrication, permitting a broader utilization of the properties afforded by plastics at reduced manufacturing costs. Although certain types of thermosetting plastic sheets can be heat-formed, recent developments have been concentrated on the vacuum and draw forming of nearly every class of thermoplastic sheet material. Predominant among these are the styrene rubber copolymers, the rubber modified styrene polymers, the acrylics, acetates, and rigid vinyls. In practice, a heated sheet is made to assume a complex shape and then cooled until rigid again. Thus to such valuable properties as light weight, toughness, integral color, moisture resistance, and chemical resistance is added the advantage of fast economical production from low cost dies.

Vacuum and draw formed plastics do not, in general, compete directly with the injection molded materials, although there are some areas of overlap. The choice between molding and forming depends first on the design and wall thickness of the part, and second, upon economic and production factors. Neither uniform wall thicknesses nor intricate details such as lugs and bosses can be produced in formed sheet as readily as by injection molding. And for quantity runs of a one-shot completely shaped part, injection molding is hard-to-beat on a cost basis. However, when the anticipated volume does not justify the cost of injection molding dies, or where strength is required in thin sections, sheet forming is often the answer.

While it is much easier to control sheet wall thickness with male and female dies than with an evacuated frame, recent developments indicate that a heated sheet need not thin out more than desired, even in very deep draws. Several functions control the wall thickness of the formed sheet. Among the most important are the manner in which heat is distributed, the rate of pulling during the drawing operation, and some pre-stretching or pre-forming of the heated sheet before vacuum is applied.

At present, lugs and bosses are impractical in sheet forming, because the operation requires material displacement. When ribs are formed, each rib will have a corresponding depression on the reverse side of the part.

MATERIALS

Practically all rigid thermoplastic sheet materials, Table I, are being fabricated today by vacuum forming, draw forming, or both. Acrylics are perhaps the most familiar. These were among the first thermoplastics to be formed from sheet stock. Acrylics possess a high degree of optical clarity and resistance to weathering, good resistance to cold flow or "creep," and are available in a complete range of colors. Acrylic parts can be designed to bear as much as 1,500 psi continuous outer fiber stress at room temperature and 750 psi at 158 F. Acrylic sheet is vacuum formed when parts are desired which differ quite radically from "surface-tension" shapes. Vacuum forming permits close detail and very nearly geometric shapes can be produced. In general, a vacuum drawn sheet of acrylic can be taken down to about 1½ times the width or diameter of the opening. While acrylic sheet is somewhat higher in cost than other widely used thermoplastic sheet, its special combination of properties has given it wide application in lighting fixtures and lighted ceilings, vending machines, aircraft canopies and enclosures, and automobile tops.

Acetates—cellulose acetate and cellulose acetate butyrate—are available in both brilliant colors and transparent forms. They form well and are readily sealed by heat or solvents. Cellulose acetate is characterized by freedom from blush and webbing in drawing operations, long shelf life without yellowing and embrittling, rigidity permitting use of comparatively thin gages of sheet, and relatively high heat resistance. Cellulose acetate butyrate is characterized by toughness, low shrinkage, improved moisture absorption, and good dimensional stability.

Rigid vinyls were among the first thermoplastic sheet materials to be vacuum formed. Vinyl chloride-acetate rigid sheets are very hard and stiff at normal temperature. Fig. 1(a) shows the general effect of temperature on the rigidity and hardness of these materials.

The vinyl chloride-acetate sheets also have a linear thermal expansion coefficient of 69×10^{-6} which is lower than that for most other plastic materials. They are also characterized by high tensile strength, a high modulus of elasticity, and some ductility. Fig. 1(b) illustrates typical tensile stress-strain curves at two different temperatures. The shape of the initial portion of the curve indicates high dimensional stability, while the moderate ductility exhibited is evidence of toughness and relatively high resistance to impact. At subzero temperatures, this ductility is lost and the rigid sheet is correspondingly much less tough.

These vinyl sheets also have high compression strength and exhibit a steep and linear stress-strain curve, a well-defined yield point, and a high percentage of deformation or "cold flow" after the yield point before failure occurs. In addition, they possess high strength in bending, torsion, and shear. Fig. 1(c) shows the effect of sheet thickness on the load needed to produce failure of the rigid sheets by high shear forces.

Polystyrene is noted for its excel-

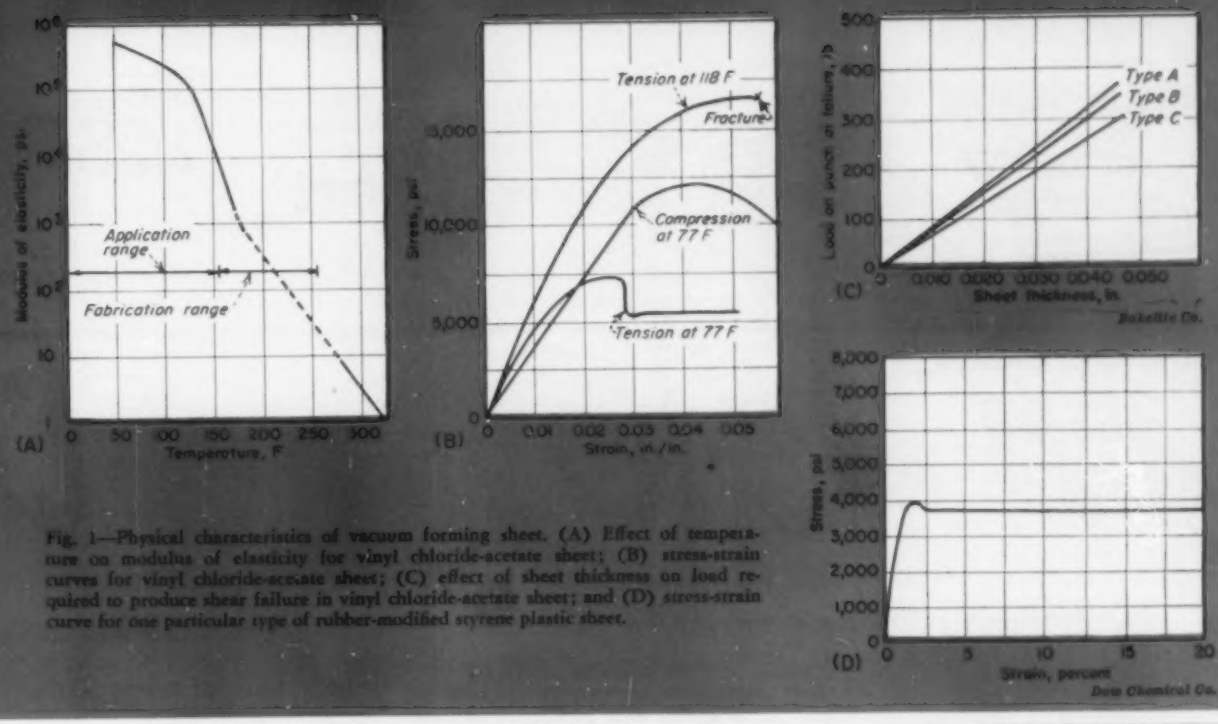


Fig. 1—Physical characteristics of vacuum forming sheet. (A) Effect of temperature on modulus of elasticity for vinyl chloride-acetate sheet; (B) stress-strain curves for vinyl chloride-acetate sheet; (C) effect of sheet thickness on load required to produce shear failure in vinyl chloride-acetate sheet; and (D) stress-strain curve for one particular type of rubber-modified styrene plastic sheet.

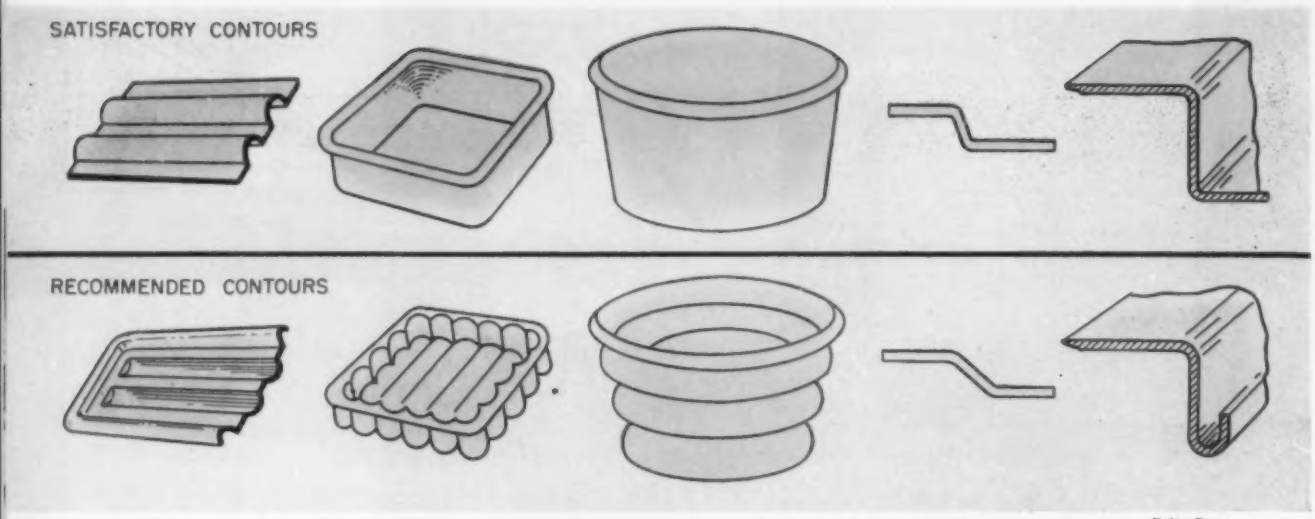
Table I—Typical Characteristics of Thermoplastic Forming Sheets (Average Values)

Material	Typical Supplier	Specific Gravity	Heat Distortion, F.	Tensile Strength psi	Flexural Strength psi	Elongation %	Impact Strength, Izod ft lb/in.	Water Absorption %, 24 hr	Dimensions, in.	Surface Finish
Modified Styrene	Campco Div., Chicago Molded Products Corp.	1.07	155–175	3,000–4,500	6,000–6,500	17–25	0.7–2.0 (0.060 in. thick)	0.10 (0.12)	Thickness: 0.005–0.125 Width: 20–60 Length: 20–96 or continuous rolls	Matte, polished
Styrene-Acrylonitrile Butadiene	The Dow Chemical Co. Sandoz Manufacturing Co. Bolta Corp. U. S. Rubber Corp.	1.05–1.24	155	4,400	5,000	3.75	10.2	0.54	Thickness: 0.0156–0.125 Width & Length: 32x62, 35x72, 35x96, 20x50	Matte, grain, polished
Nonplasticized PVC Normal impact	American Agile Corp. The Atlas Mineral Products Co. Bolta Corp.	1.40	165–175	8,500	16,000	20–30	0.5–0.8	0.032	Thickness: 0.032–1.00 Width & Length: 30x60	Polished
Rubber modified PVC High impact	American Agile Corp., Bolta Corp., B. F. Goodrich Chemical Co., Naugatuck Chemical Div., U. S. Rubber Co.	1.45	145–150	5,800	11,000	10–12	16.8	0.07	Thickness: 0.0625–0.1875; up to 48x108	Polished
Vinyl chloride-acetate copolymer	Bakelite Co., Div. Union Carbide and Carbon Co.	1.35–1.45	140–150	7,200–9,000	12,600–14,500	——	0.4–0.75 (0.1000 in. thick)	0.07–0.08	Thickness: 0.010–0.125 sheets; rolls 0.010–0.20 Width & Length: 20x50, 21½x51½, up to 54x108; or continuous rolls	Matte, Matte,
Cellulose acetate	Celanese Corp. of America Eastman Kodak Co.	1.27	130–160	5,500 7,500	——	——	2.5–3.0 (0.125 in. thick)	2–7	Thickness: 0.005–0.250 Width: Up to 44 Length: 51–61; or continuous rolls	Matte, grain, polished
Cellulose acetate Butyrate	Eastman Kodak Co.	1.22	——	5,000–6,000	9,000–12,000	60–100	——	2.0–3.0	Thickness: 0.010–0.060 Width & Length: 21x51; or continuous rolls	Matte, polished
Acrylic	Rohm & Haas Co.	1.19	190–210	8,500–9,000	16,000	——	0.4	0.3	Thickness: 0.060–0.500 Width: Up to 72 Length: Up to 102; standard sheets 100x120	Matte, patterned, polished
Polyethylene	American Agile Corp. Celanese Corp. of America	0.92	107–120	1,300	——	200	No break	0.01	Thickness: 0.0625–0.250 Width & Length: 48x72	Matte, polished

lent dimensional stability, low specific gravity and moisture resistance. Since it contains no plasticizer, its stability is high. The clear form offers excellent transparency, and it can be had in a complete range of colors. Because of its rigidity, however, its impact strength is not as great as that of the plasticized materials nor of the rubber modified forms. Recent developments in modifying polystyrene with rubbers such as butadiene, and in copolymerization of polystyrene with acrylonitrile, for example, indicate that these materials will find wide application as forming sheets.

Rubber modified sheet materials afford a combination of valuable physical properties with low cost which has led to their adoption for a wide range of uses, ranging from colorful advertising displays to large refrigerator door liners and similar industrial parts. While not as great as that of the plasticized copolymers, its impact strength is nevertheless excellent. Fig. 1(d) illustrates a typical stress-strain curve for this class of materials.

Dimensional stability of the modified styrenes is outstanding among



Bolta Corp.

Fig. 2—Comparison of "satisfactory" parts contours, and shapes "recommended" when fabricating rubber styrene copolymer sheet.

thermoplastic sheets and their moisture absorption is relatively low. These properties coupled with resistance to most common chemicals help to give these materials wide usage. They are supplied in white and in a full range of colors. Transparent forms are not at present available. However, translucent types of white possess excellent light transmission in the thinner gages and laminating properties are excellent. Thus, a printed, painted, or otherwise decorated suface can be protected by overlamination with a thin film. Standard finishes are a soft matte, and a soft calendered gloss. A recent innovation is a new high gloss surface developed primarily for refrigerator applications. When formed, sheets of this type have a brilliant porcelain-like finish which compares very favorably with that of the finest styrene injection molded parts.

Plasticized rubber-styrene copolymers lend themselves well to all of the accepted forming techniques, especially to vacuum forming and-plug-and-ring forming. Their impact strength is very high; stability is excellent. These materials can be had in attractive grained finishes or with a calendered finish to provide a smoother surface. They are not, however, available in transparent form. Their toughness and impact strength have initiated their use in applications where severe service is involved including tote boxes, material trays, and carrying cases of various kinds. The more flexible forms with high rubber content are used for such applications as motorcycle seat covers.

From the wide application of these high impact copolymer materials, certain design information has been derived, as shown in Fig. 2 for various shapes. Many products, for example, have been designed utilizing much thicker sheet than is required for the application. This is sometimes done in an effort to compensate for fabrication deficiencies causing undue thinning of the walls, insufficient ribbing that would not only enhance the product but provide much greater rigidity, and lack of metallic trim and reinforcement where sound design practice would indicate.

Wherever possible, it is highly desirable in the design of durable rubber-styrene copolymer parts to avoid cemented or fabricated sections. A fully-formed part is generally preferable to an assembled part. This point should be considered as a design principle in all rubber-styrene copolymer shapes.

In general, threads should be as coarse as possible with rounded apexes to reduce the danger of stripping. Heavy, coarse threads are much more desirable than fine, featheredged threads in rubber-styrene copolymer design.

In all cases of design, it is better to bolt sections of the material together, rather than use fasteners requiring threaded tapped holes. If parts are to be assembled and disassembled frequently, it is almost a necessity to use drilled and bolted sections, or at least self-threading screws with a sheet metal back-up part such as used in automotive door panels.

Since it has high impact resistance and resiliency, the rubber-styrene copolymer material is not a particularly rigid material. Designers should recognize this fact and attempt to build rigidity into the material by structural means, rather than material thickness.

PRIMARY MOLDING FACTORS

When close fitting parts are being produced in any of these sheet materials, three factors—mold shrinkage, part shrinkage after molding, and thermal expansion and contraction of the part—should be taken into consideration. As is the case with most other materials, the dimensions of the formed piece after it has reached room temperature are something less than those of the mold cavity. The amount of this shrinkage can vary considerably, since it is dependent upon the design of the part, and the forming conditions. There is normally little variation from piece to piece when fabrication is done under identical conditions. However, variations in these conditions may change mold shrinkage as much as 0.002 in. per inch. The usual range of mold shrinkage for these sheet materials is 0.004 to 0.008 in. per inch.

It is not possible to predict mold shrinkage precisely. Since an error of 0.002 in. per in. may occur, it is suggested that the specified tolerance be not less than 0.002 in. per in. of length

on any given dimension.

The coefficient of thermal expansion for these materials is relatively high as compared to that of metals. With rubber-modified styrene plastics, for example, it is approximately 0.000045 in. per in. per deg Fahrenheit.

Certain design factors applicable to molding plastics enter the picture when forming sheet plastics. Sharp corners are difficult to produce in forming and maintaining a uniform cross section. Liberal radii and flared and rolled edges are important to properly rigidize and strengthen formed parts. Offset sections should progress through liberal radii tangent to a 45 or 60 deg angle, rather than as violent offshoots from the original plane.

Progressive thinning, which frequently occurs as the area of the sheet is increased during drawing, should also be considered. When a 0.040 in. vinyl chloride-acetate sheet, for example, is drawn to a depth of 0.5 in., the final thickness at a critical radius can be as little as 0.016 inch.

FORMING PROCEDURES

The forming operation itself consists of two basic steps. The first is the heating of the material by electrical, gas fired or radiant heating to a temperature at which it will form readily. The second sheet is then immediately subjected to pressure in matched or single dies. The pressure can be exerted by the die itself, vacuum, compressed air or a combination of these mediums.

Best forming temperature for most materials is between 285 and 325 F. Forming below this temperature range is apt to set up strains in the part. If the temperature is excessive, blistering and discoloration is often the result. Medium-gage sheets (0.050 to 0.60 in.) can be brought to heat in about 55 sec, even by the less-efficiently controlled methods. This time can be cut down to as little as 20 sec when well-controlled infra-red units are used. Lighter gages of 0.010 to 0.020 in. can be heated in 10 to 15 seconds. Heavier gages, $\frac{1}{8}$ to $\frac{1}{4}$ in., require considerably more time—from one to five minutes, depending upon the method of heating and the thickness of the material.

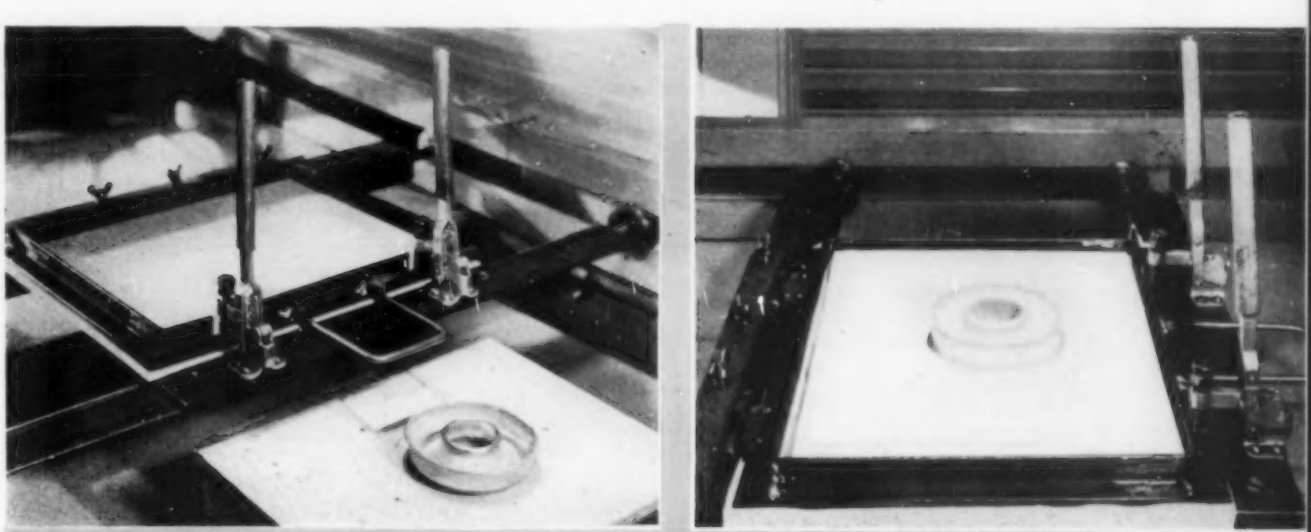
VACUUM FORMING

Probably more sheet plastic parts are being produced today by vacuum forming than by any other sheet fabricating method. Vacuum forming is relatively simple and fast, often accomplished with a single male or female mold. It is well adapted to multi-cavity forming.

The equipment required is basically simple, as shown in Fig. 3. It consists of a heating element, a frame for holding the die, a clamping device to hold the sheet, and a vacuum pump with accumulator. Compressed air for operating mechanical helpers and cooling is a valuable adjunct. Cycles can often be speeded up by cooling the mold with water.

One common arrangement incorporates a heating element which can be positioned directly over the sheet. It is important that the sheet be clamped securely, to prevent shrinkage when the material is heated and to control dimensions while forming is taking place. When the sheet is securely clamped in place over the mold, the heating element is drawn directly over it, and the heat applied. After the sheet has been softened to the required temperature, the heating element is withdrawn and the vacuum applied. The sheet snaps quickly into place, taking the contours of the mold. Upon cooling of the sheet, the clamping frame is released, the formed part removed and the operation repeated.

Another arrangement provides for the mounting of the heating element permanently along side of the frame which holds the forming die. The material is first clamped in its frame, placed beneath the heating element, and then moved over the die for forming as soon as it has reached the proper temperature. This arrangement is commonly adopted when the press has an overhead cylinder to aid the forming operation. In many cases, it can be



Campco Div., Chicago Molded Products Corp.

Fig. 3—In addition to clamping frame, vacuum forming rig includes heater for softening sheet, plunger controls and vacuum system. Left: light aluminum ring mold is placed on top of wooden plate with holes for vacuum. Right: when ring is pressed against heated sheet and vacuum applied, sheet is formed around it, holding it securely in place.

used to speed up the cycle, since one sheet can be heating while another is being formed. It is also very practical for forming heavier gage sheets with two heaters, top and bottom, to heat the sheet simultaneously on both sides.

MOLD DESIGN

Many types of materials, Table II, are used in making the molds for both vacuum forming and draw forming. Relatively inexpensive molds for low production and pilot runs are of wood, reinforced plaster, plastic resins, and sprayed metal. Quality molds for large-volume production are of finished cast aluminum, mild or cast steel, Kirksite, bronze, tempered Masonite, or high grade mahogany. One of the latest methods of mold construction utilizes electroplating to produce high grade molds at low cost.

Metal molds are preferred generally. They are strong enough to stand up under continuous production and withstand the pull of the vacuum (20 to 24 in. of Hg). They can be highly polished, particularly important in forming glossy-surfaced sheets, where even slight imperfections in the mold will induce surface flaws in the formed part. And, being good heat conductors, metal molds can be cooled more rapidly for faster cycles.

Vacuum distribution over the mold surface is afforded by suitably located holes, varying in diameter from $\frac{1}{32}$ to $\frac{1}{16}$ inch. Holes should not exceed $\frac{1}{16}$ in. or the thickness of the material to be formed, except in the forming of thinner gages of material, where holes need rarely be less than $\frac{1}{32}$ in. in diameter. Holes are usually located two or three inches apart, with particular emphasis on the points where sharp rules, edges and special details are required in the formed product.

MALE OR FEMALE MOLDS

Both male molds and female molds are widely used in vacuum forming, and many molds combine the features of both types. Each type, Fig. 4, has its particular advantages.

Generally, a male mold is indicated when (a) sharp detail in the design is wanted on the inner surface of the part; (b) a heavier section is desired at the deep part of the draw; and (c) mold costs are to be kept to the minimum. The male mold is usually constructed by cutting away the material, resulting in a simple and low cost operation. Conversely, the female mold is recommended when sharp detail, perfect finish and close tolerances are required on the exterior surface. Female molds are particularly well adapted to multi-cavity work, since the cavities can be located closer together. At the same time, it is relatively easy to form or cast a multiple-cavity female mold.

The choice of mold, therefore, is dependent on three factors—part design, production, and economy.

Table II—Relative Mold Costs in Sheet Forming*

Forming Method	Sample Application	Mold Material	Approx. Price
Vacuum	Freezer Liner (30 x 48 in.)	Mahogany	$435.00
Vacuum	Refrigerator Liner (10 cu ft unit)	Wood,	1,250.00
		Aluminum	2,800.00
Vacuum Snap-back	Tray (13 in. dia)	Mahogany	120.00
Vacuum	Television Mask (21 in. dia)	Cast Aluminum	325.00
Plug and Ring	Tote Box (18 x 14 x 6 in.)	Wood and Masonite	450.00
		Aluminum	750.00

* Based on specific application and subject to variation depending upon design.

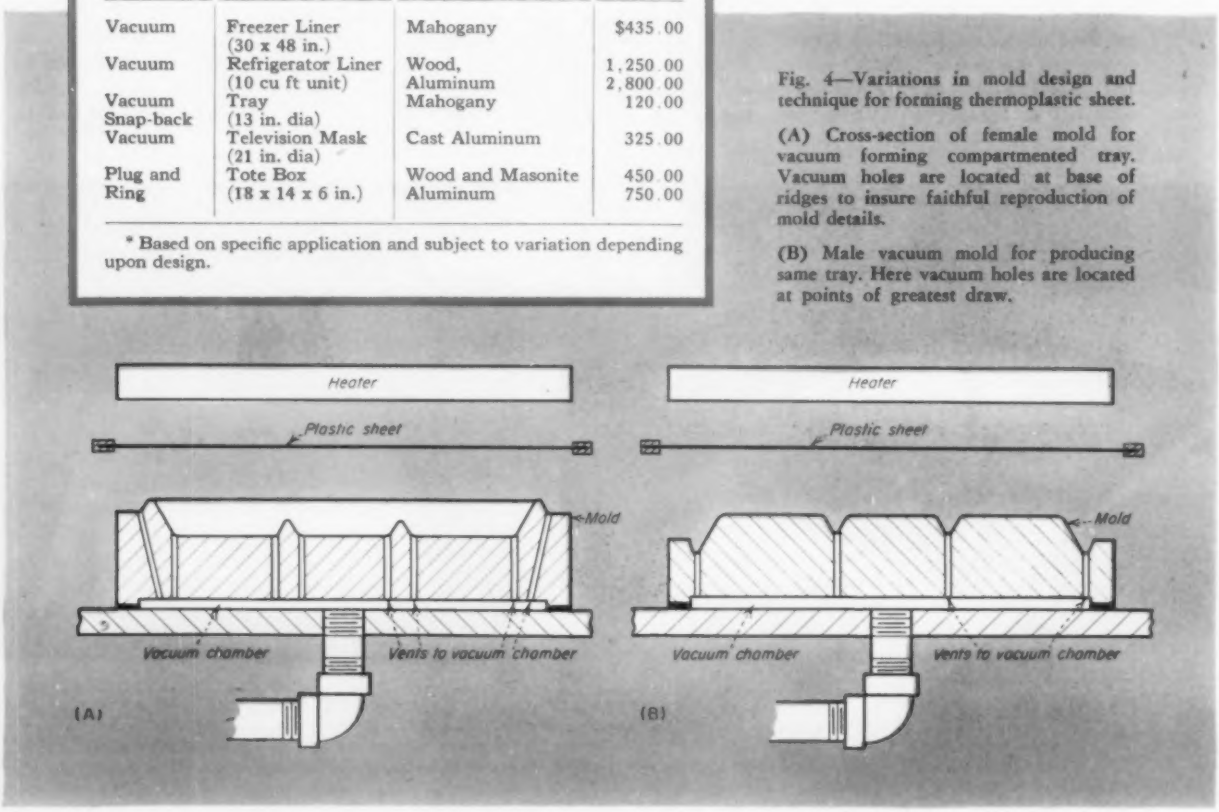


Fig. 4—Variations in mold design and technique for forming thermoplastic sheet.

(A) Cross-section of female mold for vacuum forming compartmented tray. Vacuum holes are located at base of ridges to insure faithful reproduction of mold details.

(B) Male vacuum mold for producing same tray. Here vacuum holes are located at points of greatest draw.

CONTROLLING WALL THICKNESS

In vacuum forming, the sudden pull of the vacuum will usually cause the greatest thinning to take place at the point of greatest draw, and often at a point where greater strength is needed. Using a heavier sheet to overcome this condition would be uneconomical, especially where the thickness in other areas of the part is entirely adequate.

Pattern heating is one method of reducing excessive thinning. Here, heat is held back from those areas which tend to thin out the most.

Other methods of controlling wall thickness are accomplished in the molding process itself. For example, with a female mold, a mechanical helper can be used to depress the heated sheet into the mold as far as practical before the vacuum is applied. The helper, though it does not match the mold, is designed to stretch the sheet evenly, so that the thickness differences resulting from drawing the sheet into the mold details are minimized.

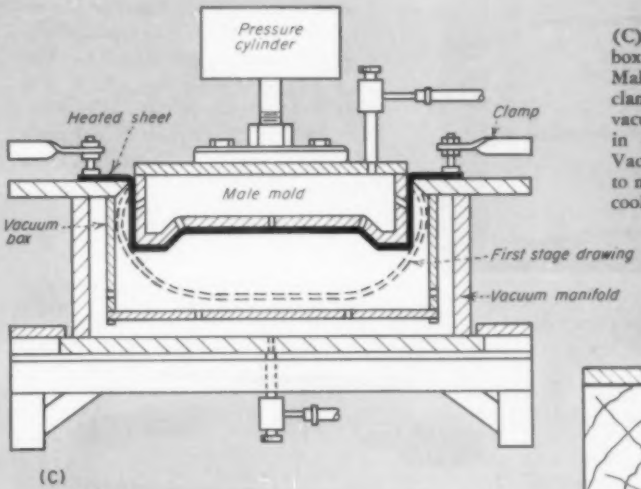
The most common and successful method used to secure uniform wall thickness is the vacuum box method. In this technique of forming, a box somewhat larger than the piece being formed is mounted in the bed of the press and connected to the vacuum accumulator. To form the part, a male mold attached to an air-actuated plunger directly above the box is used. In the first stage of the cycle, the plunger descends, acting as its own mechanical helper, to depress the heated sheet into the box. When the plunger has reached its limit of travel and is sealed against the frame, vacuum exhausts air from the box, thereby drawing the heated sheet away from the mold. Immediately, however, the vacuum is released and air admitted into the box. The "memory" or tendency of the sheet to resume its original form, causes it to snap back against the mold. If there is detail or depth in the surface of the mold, the snap back is aided by applying vacuum through the mold; at the same time it is shut off from the vacuum box. This operation of drawing the sheet away from the mold and snapping it back again can be repeated several times if necessary to insure sufficiently uniform thickness in the forming. This action has to be rapid since it must be completed before the sheet cools appreciably. Vacuum is maintained through the mold while the cooling takes place.

DRAW FORMING

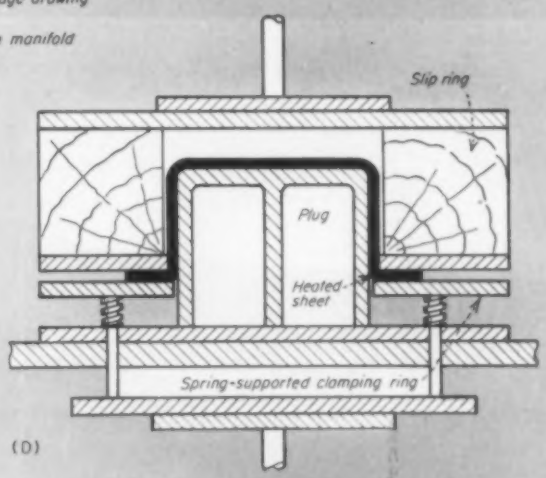
Draw forming encompasses a number of varied techniques. Pressures required are relatively low—usually from 5 to 15 psi. Pressure can be obtained from hydraulic or pneumatic cylinder, the latter often being preferred because it is fast, positive and easily adapted.

A practical method of draw forming is accomplished with matched male and female molds. The material is heated and then placed between the halves of the mold where it is formed by pressure.

One of the simplest forms of draw forming is accomplished by using a stationary male mold or plug with a draw ring which slips over it. The heated sheet is placed over the male plug and allowed to drape. The descending ring draws the wrinkles out of the material and should be in firm



(C) Snap-back forming using male mold and vacuum box to insure maximum uniformity of wall thickness. Male mold is depressed by action of cylinder against clamped heated sheet. Vacuum is first applied through vacuum box so that sheet is drawn away from mold in smooth curve, keeping wall thickness uniform. Vacuum is released in box and simultaneously applied to male mold. Sheet then assumes formed position, and cools while vacuum is maintained through mold.



(D) Plug and ring forming. Heated sheet is draped without framing over the male mold or plug. Slip ring descends over plug with enough clearance to slip past heated material. During final phase of down-stroke, ring clamps sheet against spring-supported clamping ring. As spring is depressed, material is stretched down over plug and smoothed into final form. Method is often referred to as slip forming. *Campco Div., Chicago Molded Products Corp.*

contact with the material for about the last 20 percent of the draw. The ring should fit the male plug just closely enough to allow for the gage of the stock being formed.

A variation of this technique known as slip forming is particularly valuable, for producing stronger parts such as tote boxes. With this method the blank is cut about 10 percent greater in length and width than the dimensions of the formed part. After being heated, the blank is draped over the top of the mold, thereby covering the top third of the plug. As the ring descends, the material slips past the ring till at least another third of the plug is covered. At this point, the descending ring clamps the edges of the material against another ring supported by springs. From this point onward, the pulling action draws the wrinkles out of the material. Obviously the forming ring must be well adjusted around the mold to insure even pressure on all sides. Corners of the material should be cut off at an angle to lessen pressure at the point where slippage is desired. In forming of this type, the reverse action of the lower plunger can be used to bend back the ring on itself, producing a bead or reverse curve around the edge of the material being formed.

For more difficult and complex parts, it is often feasible to combine plug and ring forming with vacuum forming. The plug and ring are used to accomplish the longer draws while the application of vacuum will produce fine detail in those sections where it is required as vital to the design.

FINISHING OPERATIONS

The basic finishing operation in sheet forming is the cutting of the sheet to the final outline of the part. In short run jobs, this is usually accomplished by cutting with a band saw or hand router and finishing the edge with a belt or spindle-type sander.

For large production runs, the most common method of trimming is punch press stamping with a steel die. Clicker-type dies are frequently used. This method has two distinct drawbacks: cost of the steel die, and introduction of a separate handling operation.

For these reasons, more progressive fabricators of thermoplastic sheet are developing techniques wherein a steel rule die is either incorporated into the mold, or operated with it, to trim the sheet at the end of the forming operation. Steel rule dies are low in cost. Trimming as a part of the forming cycle speeds up production and appreciably lowers cost per part.

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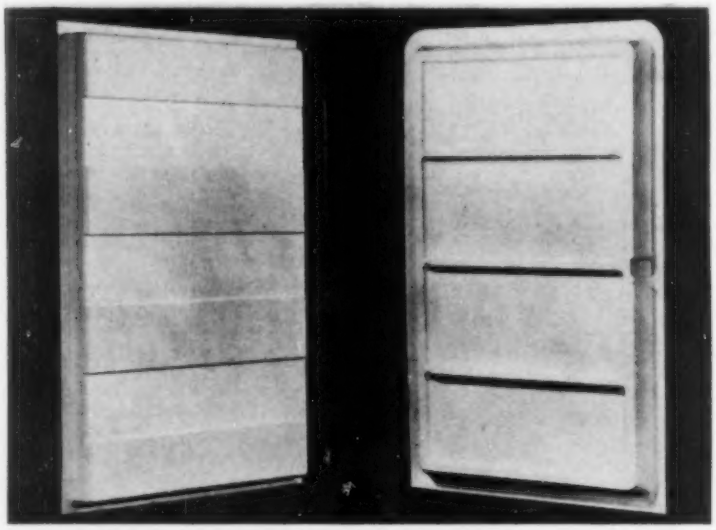


Dow Chemical Co.

Fig. 5—Typical applications of formed thermoplastic sheets.

Bolta Corp.

Locating the Shear Center in
Thin Closed Sections

Method described is applicable to any cylindrical component regardless of cross-sectional shape. Center of shear can be shifted by varying wall thickness or by constructing section with two or more materials having different moduli of elasticity. A degree of freedom is thus available to pre-fix position of shear center.

H. D. TABAKMAN
Canadair Limited

THE PROBLEM of locating the center of shear has received considerable attention in the literature. Much effort has been devoted to analyzing solid, thick hollow, or open thin cross sections. Timoshenko in his book, "Theory of Elasticity" presents a complete treatment for solid sections; Schwalbe in a relatively recent paper deals with thick hollow cross sections. But little has been done in the direction of thin closed sections.

It is common practice to assume that a mechanical or structural component under a system of transverse loads is subject to torsionless bending when the loads operate through the centroid of the section. This assumption is valid for sections possessing double symmetry since the shear stress distribution is symmetrical with respect to the principal axes of inertia. But with non-symmetrical sections, adherence to this concept leads to an erroneous evaluation of shearing stresses.

The aforesaid must not be interpreted to imply that the correct shear

NOTATION

Two letters define any particular form of stress. The first letter denotes the plane on which the stress acts and the second its direction.

zz = stress on z-plane in the direction of z-axis, psi
zs = stress on z-plane in the direction of s, psi
zx = stress on z-plane in the direction of x axis, psi
s = distance along median line from fixed origin, in.
I_x = moment of inertia about x-axis
P = applied load, lb
zs_o = shear stress at point o, psi
θ = angular distance measured from y-axis, radians
e = location of center of shear, in.
R = radius, in.
y = perpendicular distance from x-axis, in.
t = uniform wall thickness, in.
t_1 = uniform web thickness, in.
t_2 = uniform semicircle wall thickness, in.
p = distance of tangential shear from point o, in.
zs_n = shear stress at point n in web, psi
zs_m = shear stress at point m in semicircle, psi
zs_a = shear stress at a, psi
U = strain energy due to shear stress, lb-in.
G = modulus of rigidity
M = bending moment, lb-in.

stress distribution cannot be established without determining first the position of the center of shear. The contrary is the case; a point fully explained in the analysis that follows:

Design requirements often lead to the use of cross sections having shapes which clash sharply with requirements of minimum elastic deformation. Torsional deformations, for example, are generally far more serious than those caused by bending or shear. This is particularly true of open thin cross sections because their inherent low torsional rigidity is normally only a fraction of their flexural rigidity. By locating the center of shear of such a cross section torsion can be avoided altogether or at least reduced to a negligible quantity. The method described below is a means to this end.

Distribution of Shear Stress

A thin-walled uniform cantilever beam having a cross section of arbitrary shape as shown in Fig. 1 (A) and (B) is subjected to concentrated load P at the unsupported end. Consider an element in this section at a distance s from Q as measured along the median line. This is shown in Fig. 1 (C) along with the three stress components at a point on its principal planes. Ignoring body forces, generalized equations of stress equilibrium are

$$\frac{\partial zz}{\partial z} + \frac{\partial zs}{\partial s} + \frac{\partial zx}{\partial x} = 0$$

$$\frac{\partial xx}{\partial x} + \frac{\partial xs}{\partial s} + \frac{\partial xz}{\partial z} = 0$$

$$\frac{\partial ss}{\partial s} + \frac{\partial sz}{\partial z} + \frac{\partial sx}{\partial x} = 0$$

Since the inner and outer surfaces of the tube are free from any form of loading and the wall thickness is small compared with the overall dimension, the following stress conditions exist:

$$xx = ss = 0$$
$$sx = \tau z = zs = sx = 0$$

Thus the problem becomes one of plane stress distribution and the general equations of equilibrium become:

$$\frac{\partial zz}{\partial z} + \frac{\partial zs}{\partial s} = 0 \qquad \text{(a)}$$

$$\frac{\partial sz}{\partial z} = 0$$

From the condition of complimentary shear stresses, $sz = zs$. Therefore

$$\frac{\partial sz}{\partial z} = \frac{\partial zs}{\partial z} = 0$$

which implies the shear stress zs at any point in the cross section is constant along the length of the tube. Then, from Eq (a),

$$\frac{\partial zz}{\partial z} = -\frac{\partial zs}{\partial s} \qquad \text{(a.1)}$$

If the bending moment at a distance z from the point of application of P is M and the second moment of area about the principal axis of bending is I_x, the bending stress at a distance y from the neutral axis becomes

$$zz = \frac{M}{I_x} y = \frac{Pz}{I_x} y$$

and

$$\frac{\partial zz}{\partial z} = \frac{P}{I_x} y$$

Substituting in Eq (a.1)

$$\frac{\partial zs}{\partial s} = -\frac{P}{I_x} y$$

and integrating this last equation,

$$zs = -\frac{P}{I_x}\int_o^s y\,ds + zs_o \qquad (1)$$

where zs_o is the shear stress at $s = 0$.

When the value of zs_o is known, Eq (1) gives the shear stress in the section at any point distance s measured along the median line from an arbitrarily chosen origin, such as Q in Fig. 1 (B). In the case of open sections, the value of zs_o presents no difficulty in establishing the shear stress distribution, provided the origin of s is fixed at the free edge; ie $zs_o = 0$.

Closed sections present a different problem because the value of zs_o is statically indeterminate; its value can be determined by applying the principle of the least strain energy. Since the strain energy attributable to bending is independent of the position of the applied load along the principal axis of inertia of the section, the strain energy due to shear is all that need be considered. Total strain energy U of cross section per unit length of tube is

$$U = \int \frac{zs^2}{2G}\, t\, ds \qquad (2)$$

In accordance with the principle of minimum strain energy

$$\frac{\partial U}{\partial zs_o} = 0 \qquad (3)$$

and differentiating Eq (2) with respect to zs_o

$$\frac{\partial U}{\partial zs_o} = \frac{t}{G}\int zs\left(\frac{\partial zs}{\partial zs_o}\right) ds = 0 \qquad (4)$$

Eq (4) yields the value of zs_o and, with Eq (1), the shear stress at any point can be calculated.

Location of Center of Shear

Once the shear stress distribution is known, the position of the center of shear is not difficult to determine. The shearing force on an element distance s from the origin acting in a direction tangent to the section is $zs\ t\ ds$ and the moment of this force about any arbitrary point in the plane of the section, point o in Fig. 1 (B) for example, is $zs\ t\ p\ ds$. Here p is the perpendicular distance from o to the shear force in question. The total moment about o due to the shear stress is

$$M = t \int zsp\ ds \qquad (5)$$

For equilibrium, the moment due to the shear stresses must be equal and opposite in sense to that associated with the external load P.

$$-Pe = t \int zsp\ ds$$

or

$$e = -\frac{t}{P} \int zsp\ ds \qquad (6)$$

where e is the distance from o at which P must act to insure torsionless bending.

In the case of sections with one axis of symmetry subject to a load acting normal to the axis, the shear stresses are symmetrical. This places the center of shear somewhere along the axis of symmetry, and the value of e, as determined by Eq (6), defines its location. With non-symmetrical cross sections, the center of shear is located by first considering a load acting normal to one principal axis and then normal to the complimentary principal axis. In both cases, the process of analysis is conducted along the lines described above. The examples that follow illustrate the use of this technique.

Typical Applications of Method

From the foregoing analysis, it is clear that the process of determining the shear stress distribution is accomplished through the application of Eqs (1) and (4). To illustrate the practical application of this method, three separate problems are presented below. For the sake of simplicity, all three are based on same cross section.

1—Uniform Wall Thickness

Consider the semicircular section, Fig. 2 (A), bounded by a web across the diameter and subjected to bending about ox-axis. Symmetry of the section establishes the center of shear somewhere along this axis. For the same reason, only half the section need be considered when calculating the shear stress distribution.

In view of the abrupt change in section contour at point a in Fig. 2 (A), parts oa and ab are treated separately. Taking part oa first, the shear stress at any point n distance s from origin o is, in accordance with Eq (1),

$$zs_n = -\frac{P}{I_z} \int_o^s y\ ds + zs_o$$

In this particular case, $s = y$, so that

$$zs_n = -\frac{P}{I_z} \int_o^s s\ ds + zs_o$$

$$= -\frac{P}{I_z} \left(\frac{S^2}{2} \right) + zs_o$$

Shear stress at a, distance R from o is

$$zs_a = -\frac{P}{I_z} R^2 + zs_o$$

Consider now part ab of the section. The shear stress at point m located at an angular distance θ from the y-axis is, in accordance with Eq (1)

$$zs_m = -\frac{P}{I_z} \int_o^\theta R^2 \cos\theta\ d\theta + zs_a$$

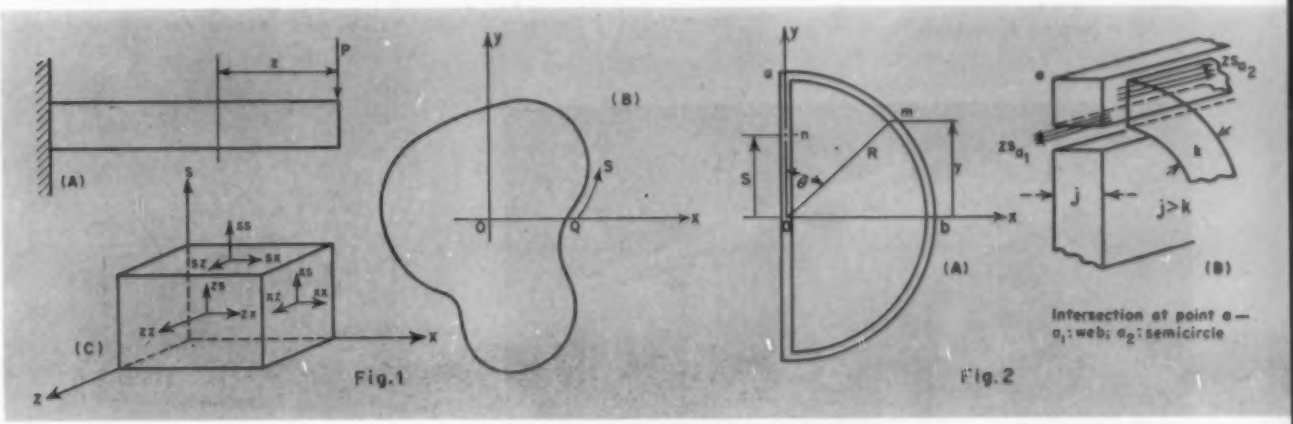


Fig. 1—Thin-walled constant-thickness uniform cantilever beam (A) loaded at P has cross section of arbitrary shape, the median line of which is shown in (B). Element is taken at random distance s from Q along the median. Perspective view (C) represents three stress components at a point on principal planes of this element, which is used for analytical purposes.

Fig. 2—Semicircular section (A) bounded by web along diameter of uniform thickness throughout is loaded in bending about ox-axis. By virtue of symmetry, center of shear lies somewhere along this axis. If web and semicircle are each of uniform but different thicknesses, the center of shear moves away from this original position. The web and semicircle must therefore be treated separately in order to make a complete analysis (B) and the equilibrium at point a given special consideration.

Noting that $y = R\cos\theta$, $ds = Rd\theta$ and zs_a has the same significance with respect to the shear at a as does zs_o at o, Eq (1) is applied using point a as origin. After substituting for zs_a and integrating,

$$zs_m = -\frac{PR^2}{I_x}(1/2 + \sin\theta) + zs_o$$

To calculate the stress distribution in the section, the value of zs_o must first be established from Eq (4). Considering part oa

$$\left|\frac{\partial U}{\partial zs_o}\right|_{oa} = \frac{t}{G}\int_o^R\left(-\frac{Ps^2}{gI_x} + zs_o\right)ds$$
$$= \frac{t}{G}\left(-\frac{PR^3}{6I_x} + Rzs_o\right)$$

and similarly, part ab

$$\left|\frac{\partial U}{\partial zs_o}\right|_{ab} = \frac{t}{G}\int_o^{\pi/2}\left[-\frac{PR^2}{I_x}(1/2 + \sin\theta) + zs_o\right]R\,d\theta$$
$$= \frac{t}{G}\left[-\frac{PR^3}{I_x}(1 + \pi/4) + \pi/2Rzs_o\right]$$

In accordance with Eq (4), the total for the two parts is

$$\left|\frac{\partial U}{\partial zs_o}\right|_{\text{total}} = 2\left(\left|\frac{\partial U}{\partial zs_o}\right|_{oa} + \left|\frac{\partial U}{\partial zs_o}\right|_{ab}\right) = 0$$

$$\frac{t}{G}\left[-\frac{PR^3}{6I_x} + Rzs_o - \frac{PR^3}{I_x}(1 + \pi/4) + \frac{\pi R}{2}zs_o\right] = 0$$

$$zs_o = \frac{PR^2}{I_x}\left(\frac{3\pi + 14}{6\pi + 12}\right) \qquad (7)$$

Substituting for zs_o, the equations for the shear stress distribution along oa and ab become, respectively

$$zs_n = \frac{P}{I_x}\left[-\frac{s^2}{2} + R^2\left(\frac{3\pi + 14}{6\pi + 12}\right)\right]$$

$$zs_m = -\frac{P}{I_x}\left(1/2 + \sin\theta - \frac{3\pi + 14}{6\pi + 12}\right)$$

The shearing stress distribution having been established, the position of the center of shear is calculated by applying Eq (6). Taking moments about o and observing that the moment due to shearing stress in web is zero,

$$e = \frac{t}{P}\int_o^{\pi}\frac{PR^4}{I_x}\left(\sin\theta + 1/2 - \frac{3\pi + 14}{6\pi + 12}\right)d\theta$$

Since $p = R$.

$$e = \frac{tR^4}{I_x}\left[2 + \pi\left(1/2 - \frac{3\pi + 14}{6\pi + 12}\right)\right]$$
$$= \frac{1.18tR^4}{I_x}$$

Also

$$I_x = \frac{\pi}{2}tR^3 + 2/3tR^3 = 2.236tR^3$$

Substituting for I_x in the last expression for e

$$e = \frac{1.18R}{2.236} = 0.582R$$

This distance from origin o compares with a centroid located at $0.387R$ from the same origin.

2—Variable Wall Thickness

Consider the case of the previous example when the web and semicircle are of uniform but differing thicknesses. The shear stresses in these two parts of the section at point a, Fig. 2, are not the same. As before

$$zs_n = -\frac{P}{I_x}\left(\frac{s^2}{2}\right) + zs_o$$

Using suffixes *1* and *2* to denote the web and semicircle, respectively, the shear stress at a in the web is

$$zs_{a1} = -\frac{P}{I_x}\left(\frac{R^2}{2}\right) + zs_o$$

The value of zs_{a2} is established by considering the equilibrium of the element at a formed by the intersection of the inner and outer contours of the web and semicircle as shown in Fig. 2(B). Bearing in mind the condition of complimentary shear stress, the following relationship obtains

$$zs_{a1}(t_1) = zs_{a2}(t_2)$$

or

$$zs_{a2} = zs_{a1}\frac{t_1}{t_2} = \frac{t_1}{t_2}\left(-\frac{PR^2}{2I_x} + zs_o\right)$$

Considering point m as in Fig. 2(A), the shear stress is

$$zs_m = -\frac{P}{I_x}\int_o^{\theta}R^2\cos\theta\,d\theta + zs_{a2}$$
$$= -\frac{PR^2}{I_x}\sin\theta + \frac{t_1}{t_2}\left(-\frac{PR^2}{2I_x} + zs_o\right)$$

Applying Eq (4) to determine zs_o and proceeding as in the first example,

$$\left|\frac{\partial U}{\partial zs_o}\right|_{oa} = \frac{t_1}{G}\left(-\frac{PR^3}{6I_x} + Rzs_o\right)$$

and similarly, part ab

$$\left|\frac{\partial U}{\partial zs_o}\right|_{ab} = \frac{t_2}{G}\int_o^{\pi/2}\left[-\frac{PR^2}{I_x}\sin\theta + \frac{t_1}{t_2}\left(-\frac{PR^2}{2I_x} + zs_o\right)\right]R\,d\theta$$
$$= \frac{t_2}{G}\left[-\frac{PR^3}{I_x}\left(1 + \frac{\pi t_1}{4t_2}\right) + \frac{\pi Rt_1}{2t_2}zs_o\right]$$

As above, the total becomes,

$$\left|\frac{\partial U}{\partial zs_o}\right|_{\text{total}} = 2\left(\left|\frac{\partial U}{\partial zs_o}\right|_{oa} + \left|\frac{\partial U}{\partial zs_o}\right|_{ab}\right) = 0$$

or

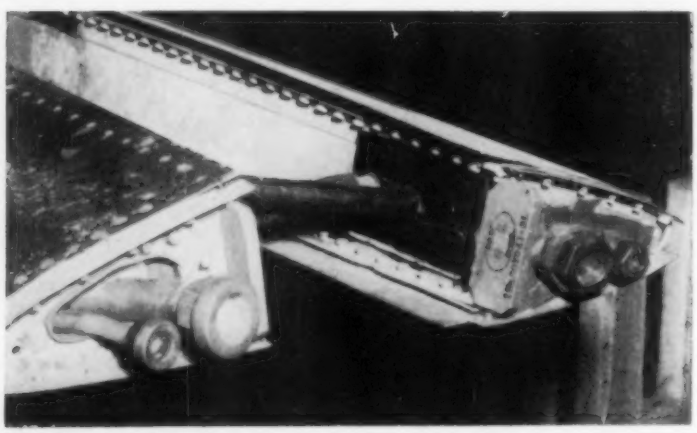
$$\frac{t_1}{G}\left(-\frac{PR^3}{6I_x} + Rzs_o\right) + \frac{t_2}{G}\left[-\frac{PR^3}{I_x}\left(1 + \frac{\pi t_1}{4t_2}\right) + \frac{\pi Rt_1}{2t_2}zs_o\right] = 0$$

from which

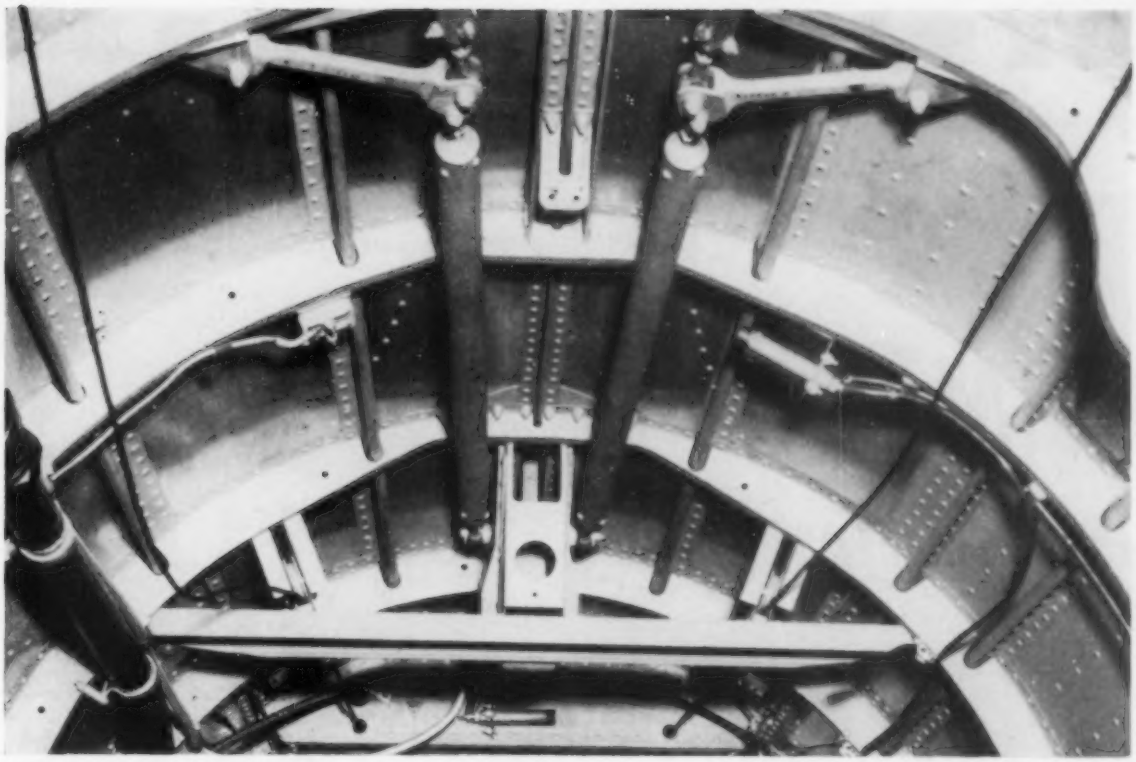
$$zs_o = \frac{PR^2}{12(\pi + 2)I_x}\left(6\pi + 4 + 24\frac{t_2}{t_1}\right)$$

and the equations for the shear stress distribution in oa and ab become

$$zs_n = -\frac{P}{2I_x}\left[s^2 - \frac{R^2}{6(\pi + 2)}\left(6\pi + 4 + 24\frac{t_2}{t_1}\right)\right]$$



Hollow ribbed tubular structure at right has semi-symmetrical cross section and shear center lies on horizontal axis. Section at left is non-symmetrical and shear center is determined by the analytical method described fully in the text.



Aircraft-transverse member of lipped cross section with centrally-mounted control bracket. Applied load operates parallel to longitudinal axis. If bracket is mounted at center of shear, transverse member will be free from torsional deformation.

$$zs_m = -\frac{PR^2}{I_x}\left\{\sin\theta - \frac{t_1}{t_2}\left[-1/2 + \frac{1}{12(\pi+2)}\left(6\pi+4+24\,\frac{t_2}{t_1}\right)\right]\right\}$$

The center of shear can now be established in the same manner as in the first example.

$$e = -\frac{t_2}{P}\int_o^\pi \frac{PR^2}{I_x}\left\{-\sin\theta + \frac{t_1}{t_2}\left[-/2 + \frac{1}{12(\pi+2)}\left(6\pi+4+24\,\frac{t_2'}{t_1}\right)\right]\right\} d\theta$$

$$e = \frac{t_2R^4}{I_x}\left\{2 - \frac{\pi t_1}{t_2}\left[-1/2 + \frac{1}{12(\pi+2)}\left(6\pi+4+24\,\frac{t_2}{t_1}\right)\right]\right\}$$

Suppose $t_1 = 2\,t_2$, then

$$e = \frac{t_2R^4}{I_x}\left\{2 - 2\pi\left[-1/2 + \frac{1}{12(\pi+2)}\left(6\pi+4+12\right)\right]\right\}$$

Substituting

$$I_x = t_2R^3\left(\frac{3\pi+8}{6}\right)$$

and evaluating

$$e = 0.547R$$

Similarly, if $t_2 = 2\,t_1$, then

$$I_x = \left(\frac{3\pi+2}{2}\right)t_1R^3$$

and

$$e = 0.516R$$

3—Open Sections

As the third example, consider the shift of the center of shear when the section analyzed in the first example is cut at center o in Fig. 2, thus transforming the section from a closed to an open one. The method of analysis is the same as that adopted previously, but with one important variation. Since the edge at o is free, $zs_o = 0$ and the problem is greatly simplified.

The shear distribution along od is

$$zs_s = -\frac{P}{I_x}\int_o^s s\,ds = -\frac{P}{I_x}\left(\frac{s^2}{2}\right)$$

and

$$zs_a = -\frac{PR^2}{2I_x}$$

Similarly,

$$zs_m = -\frac{P}{I_x}\int_o^\theta R^2\cos\theta\,d\theta + zs_a$$

$$= -\frac{PR^2}{I_x}(\sin\theta + 1/2)$$

Again taking moments about o and applying Eq (6)

$$e = \frac{t}{P}\int_o^\pi \frac{PR^3}{I_x}(\sin\theta + 1/2)\,d\theta$$

$$= \frac{tR^3}{I_x}(\pi/2+2)$$

Substituting $I_x = t\,R^3\,(\pi + 1)$ and evaluating,

$$e = 1.027R$$

which indicates that the center of shear lies outside the section contour.

To carry the analysis a step further, if the web is removed, a becomes a free edge, $zs_a = 0$, and the shearing stress in the remaining semicircle is

$$zs_m = -\frac{P}{I_x}\int_o^\theta R^2\cos\theta\,d\theta = -\frac{PR^2}{I_x}\sin\theta$$

and

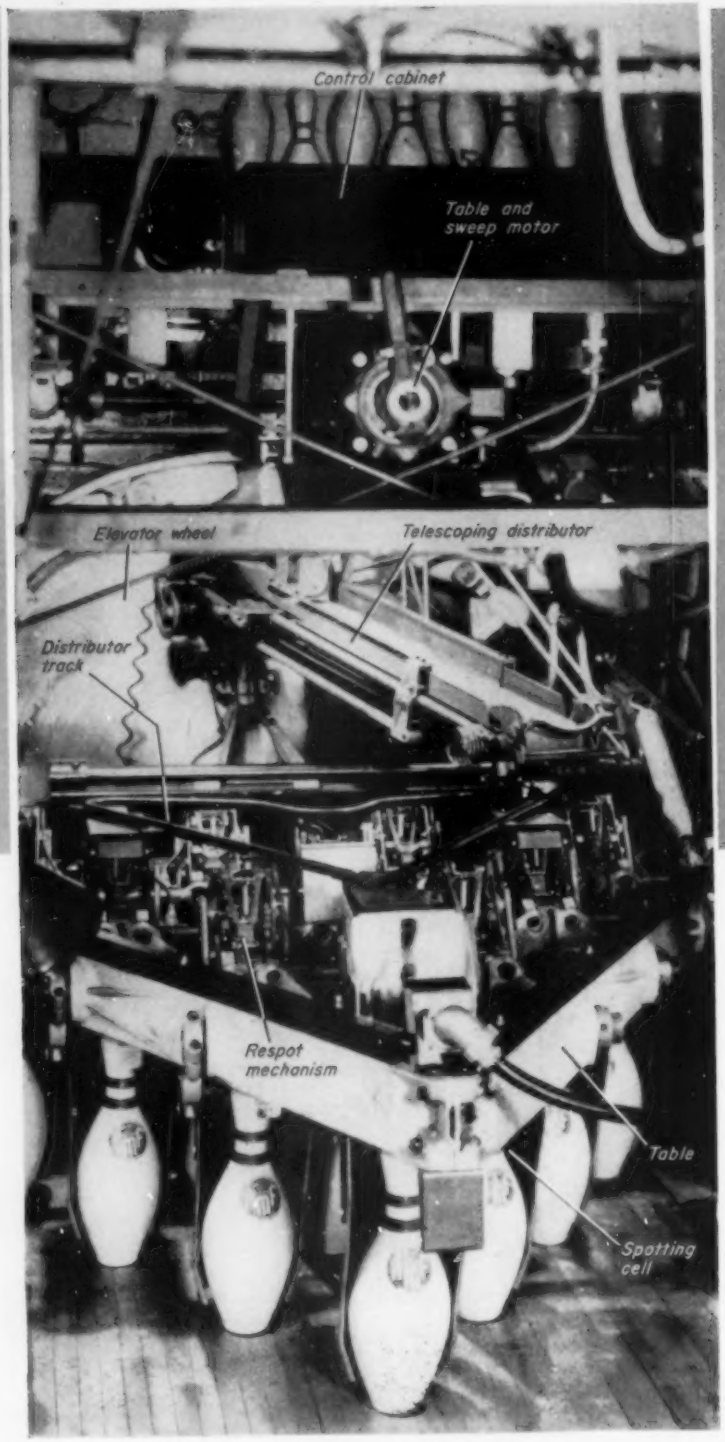
$$e = -\frac{t}{P}\int_o^\pi \frac{PR^3}{I_x}\sin\theta\,d\theta = \frac{2tR^3}{I_x}$$

Substituting $I_x = \pi/2R^3t$ and evaluating,

$$e = \frac{4}{\pi}R$$

AMF Pinspotter*

A Study in Ingenious Mechanisms



IN THIS OVERALL VIEW of the machine, the sweep bar has just returned forward and is therefore out of the picture. Next movement of the table is down and back to release the pins, then up, at which time the pin holders, now in the vertical position, tilt forward and the distributor starts to fill the table with a new set of pins. Concurrently, the respot cells, the mechanisms of which can be seen over the top of the channel, return to a horizontal position ready to pick up standing pins.

IN NEW PRODUCTS

Original specifications for the automatic bowling pin setter now being produced in quantity by the Buffalo, N. Y. and Shelby, Ohio plants of American Machine and Foundry Company confronted the engineering department with difficult and conflicting requirements. The machine had to be completely automatic from pinspotting and ball return to cycling upon indications of a foul (Table I) yet production costs had to be sufficiently low to justify the replacement of labor that works for 10c to 12c per game. It had to handle balls ranging from 7½ to 8¼ in. diameter and pins that were not only peculiarly shaped but might be splintered or re-worked, yet trouble frequency had to be low. It had to respot a pin to the position from which it was picked up after clearing the alley of dead wood following the first ball, yet be sufficiently strong to withstand constant pounding and abuse. Above all, it had to operate on a fast cycle: the average bowler throws his first ball 12.2 sec after the previous bowler has thrown his second, and his second ball 12.8 sec after the first.

Basically, the machine consists of 10 main elements: the carpet, which conveys the pins to the revolving elevator; the cushion, which stops the ball and flying pins and actuates the cycle; the circular elevator, which carries the pins to the distributor; the distributor, which deposits the pins in the table; the table, which spots and re-spots the pins on the alley; the sweep, which clears the alley of pins; ball return system; the "pinvisor"* signal device, which indicates the pins remaining on the alley; the foul detector system; and the electrical chassis.

Insofar as possible, each of these elements is comprised of self-contained mechanical components. All moving parts either run continuously or on a repetitive cycle in order to keep wear and control complexity to a minimum. As it is, five combinations of four basic circuits, not including the pinfall indicating device and foul detector, are sufficient to control the cycles. These and other features are described on the following pages.

As of June 1, 1954, AMF had installed more than 2,400 Automatic Pinspotters in commercial bowling establishments. According to Morehead Patterson, AMF board chairman and president, monthly production will be stepped up from 250 machines per month to 400 giving a Pinspotter rental income of $4 million in 1954. At this rate of production, the Pinspotter should soon become a very significant portion of the company's business which in 1953 amounted to more than $139 million.

* Trade Mark

Table I—Sequence of Pinspotter Operations

SPARE—1st BALL

(1) The ball hits the cushion actuating the cycle switch; (2) the guard drops to protect the machine; (3) the table descends to pick up standing pins; (4) the pin sweep goes through and clears the alley of "dead wood"; (5) the table respots the pins. During this time, the pins are swept back to the elevator and the ball is returned to the bowler; this occurs during all cycles and will not further be indicated.

SPARE—2nd BALL

(1) The ball hits the cushion, actuating the cycle switch; (2) the guard drops to protect the machine; (3) the pin sweep goes through and clears the alley of "dead wood"; (4) the table descends and sets new pins in on the alley; (5) as the table starts up, it is filled with pins.

STRIKE

(1) The ball hits the cushion, actuating the cycle switch; (2) the guard drops to protect the machine; (3) the table descends; (4) the pin sweep clears the alley; (5) the table descends again and sets new pins; (6) as the table starts up, it is filled with pins.

FOUL—1st BALL

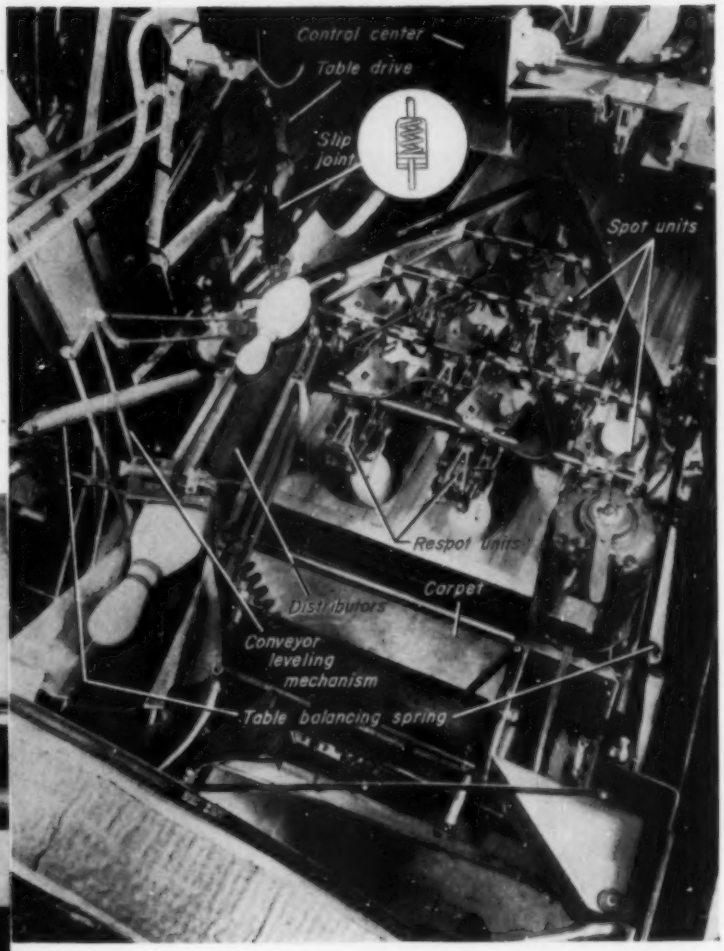
(1) The ball hits the cushion, actuating the cycle switch; (2) the guard drops to protect the machine; (3) the sweep drops and clears the alley of "dead wood" and standing pins; (4) the table descends and sets a new set of pins; (5) the machine indicates a second ball, as on a spare.

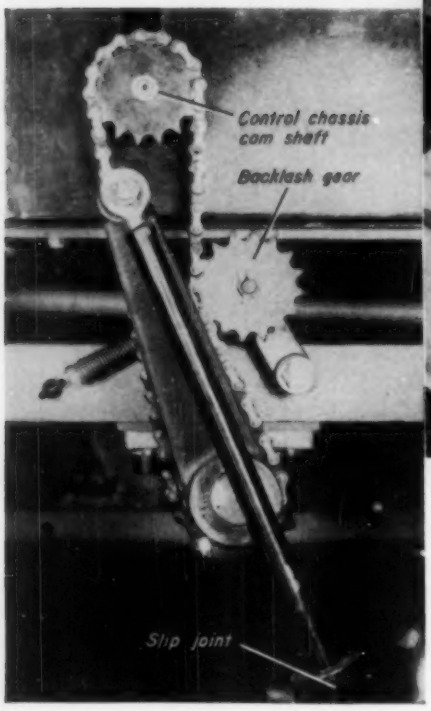
FOUL—2nd BALL

(1) The machine operates as on second ball of a spare.

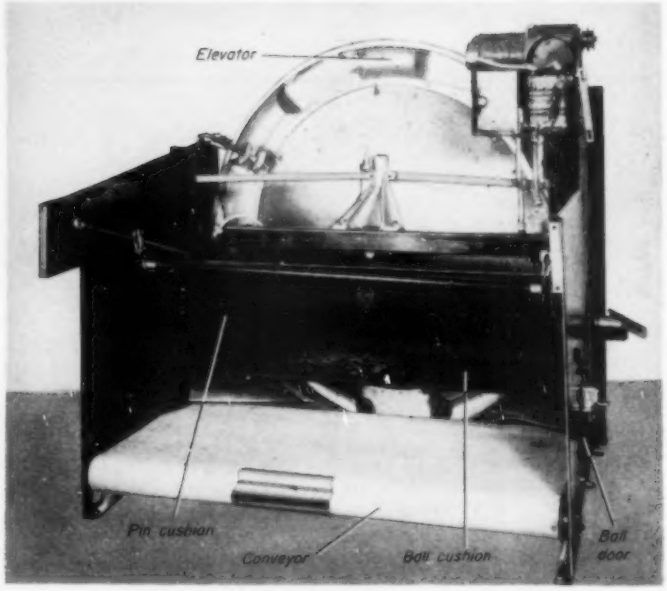
AMF Pinspotter (continued)

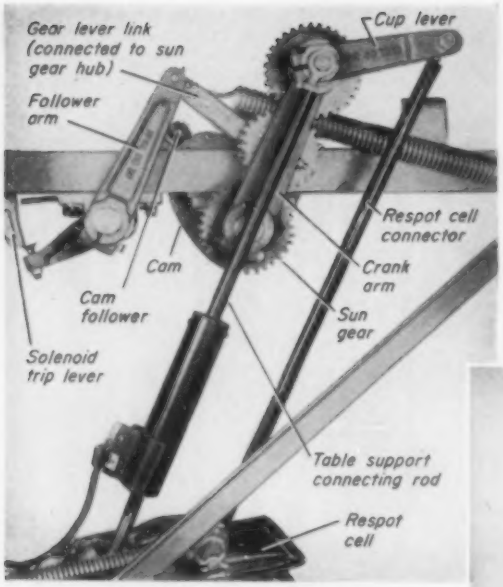
BACK-END OF TABLE. The frame is a beam truss structure mounted on bearings that carry the bending loads. It is raised and lowered by the crank mechanism shown below. Actually, the table is so balanced that it spots the pins when the restraining force exerted by the rod is removed. The "slip joint" is actually a spring mounted member that exerts positive but yielding force on the table to operate the respot cells. The gear shown below prevents backlash, while the top sprocket drives the cycling cam.





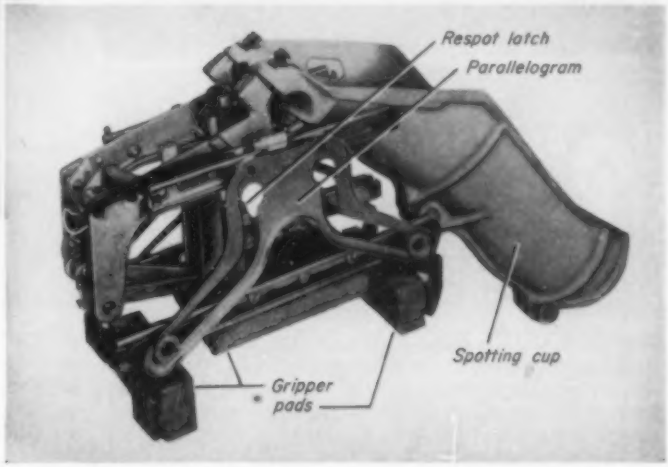
PIT COMPONENTS. After the ball hits the pins knocking them off the cud of the alley, the conveyor carries them back to the elevator, which picks them up and carries them to the distributor. The ball is stopped by the cushion, which actuates the cycle; it then spins to the right, trips the ball door, and is elevated and returned to the bowler.

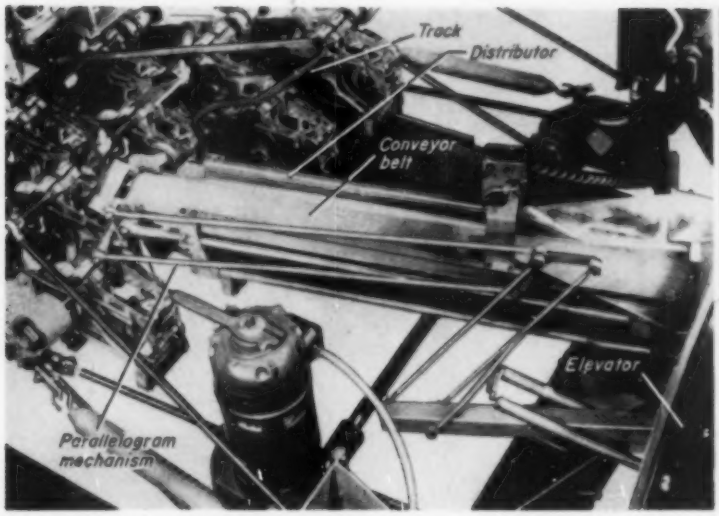


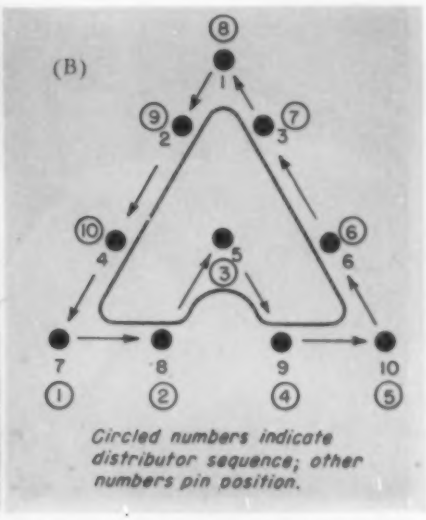


(ABOVE) Position of the spot-respot cells are controlled by this cam operated planet and sun gear. The sun gear can be latched in a fixed position, or unlatched to move back and forth with the cam. When the sun gear is fixed, the respot units are rotated into position; when it is unlatched and operative, the spotting shoes are in position, as shown in the machine's overall view.

(BELOW) Spot-respot cells are self-contained units that are clamped to supporting shafts by four cap screws. Control wires are carried through the shaft. When in the respot position, as shown here, the cell is lowered until it contacts a pin. Further depression trips the parallelogram mechanism so that the bottom pad moves upward. As this happens, the side clamps move inward to contact the pin, the top rollers centering so that each side clamp moves an equal distance. Continued movement clamps the pin firmly, and latches the mechanism.



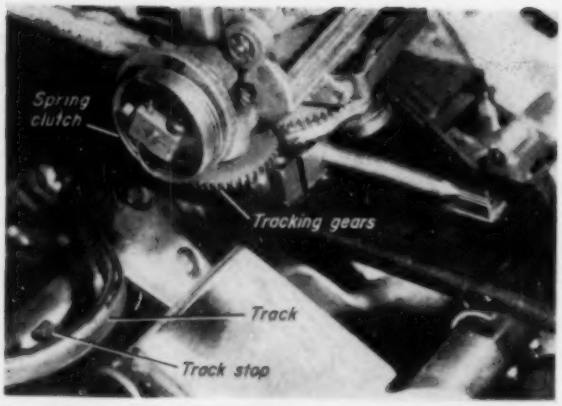


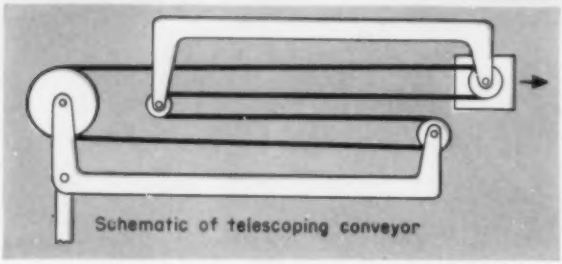


THE PIN DISTRIBUTOR is a telescoping conveyor that is mounted frame to frame on rollers and is pivoted in two planes. It rides on a precision molded track following the sequence shown at (B), being held level by a parallelogram mechanism. At each spotting cell, the conveyor hits a stop and can move to the next position only after a pin hits the flipper release mechanism, indicating that the cell is filled. A cam release on the elevator is closed to stop pin delivery when (1) the pin counter over the conveyor reaches 10; and (2) the conveyor returns to the starting point, thus tripping a stop switch.

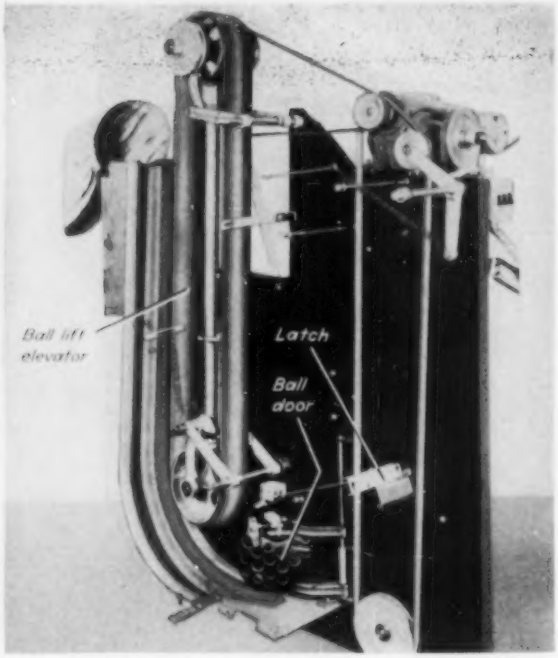
The outstanding mechanical features in this element of the design are the constant torque coupling that drives the distributor and the universal joint driving the belt.

AMF Pinspotter (continued)

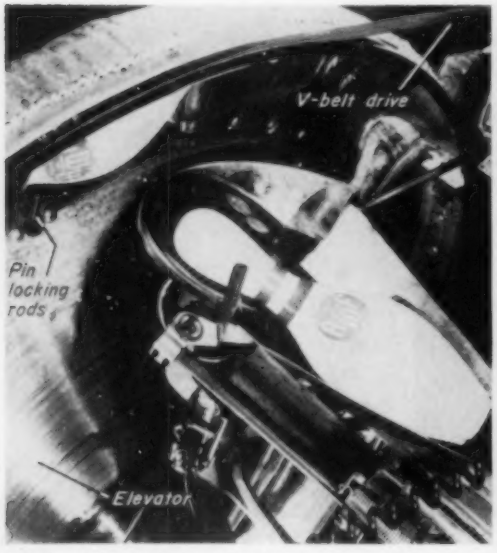


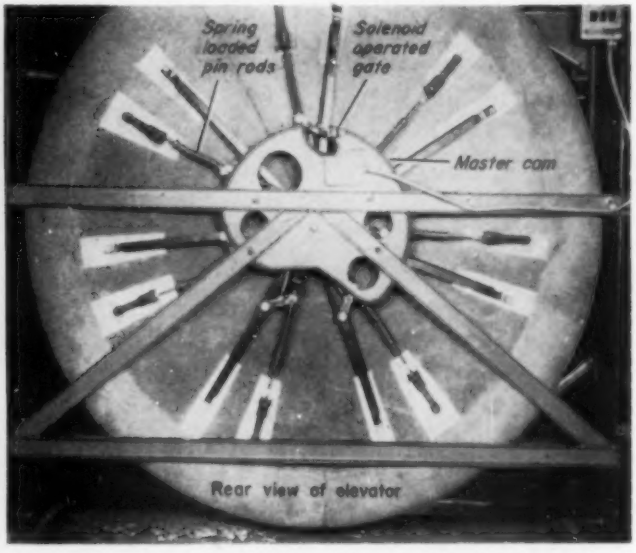


A CONNECTING ROD, driven through a universal joint by the motor powering the drum and ball lift, operates the distributor. The conveyor belt, in turn, drives the tracking gears at the end of the distributor through a small constant torque power cam that slips continuously when the distributor is stationary, before it starts tracking.

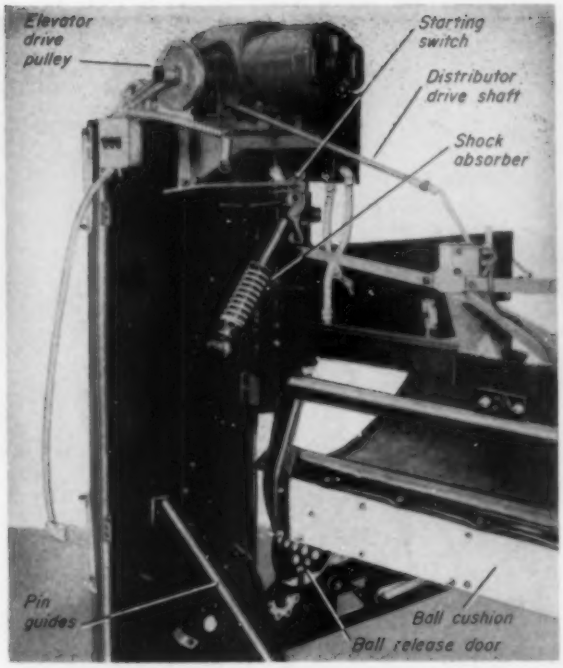


A SINGLE BALL LIFT handles two machines. As one door swings open, it operates a latching mechanism which locks the other door. As the ball rolls down the trough, it contacts the elevator which is connected to the frame by a modified parallelogram system. When ball reaches the top, belt tension pushes it down the return track.

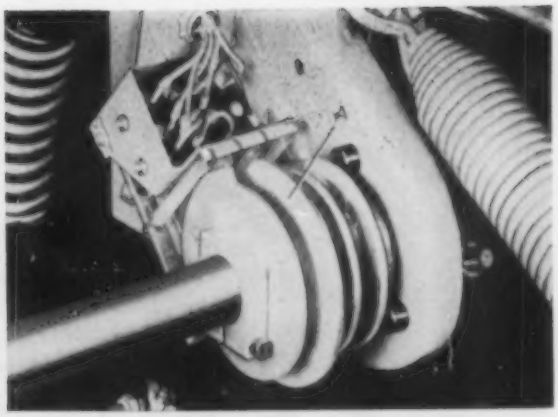


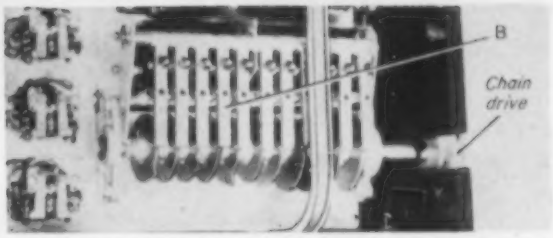


THE ELEVATOR WHEEL has seven pockets around the periphery. Pins are guided from the pit conveyor into the pockets by sheet metal guides attached to the machine side frames and are clamped into position by rods that extend through the wheel. These rods—one for each pocket—are spring mounted and ride on a master cam. If the gate on the cam is opened, the rod is released and the pin drops onto the distributor. Because the bowling pin is always released at its center of gravity, the neck hangs over the edge of the pan and the pin is moved end-first along the belt and into a spotting cell. If the gate is closed, the pin simply returns to the bottom of the pit.

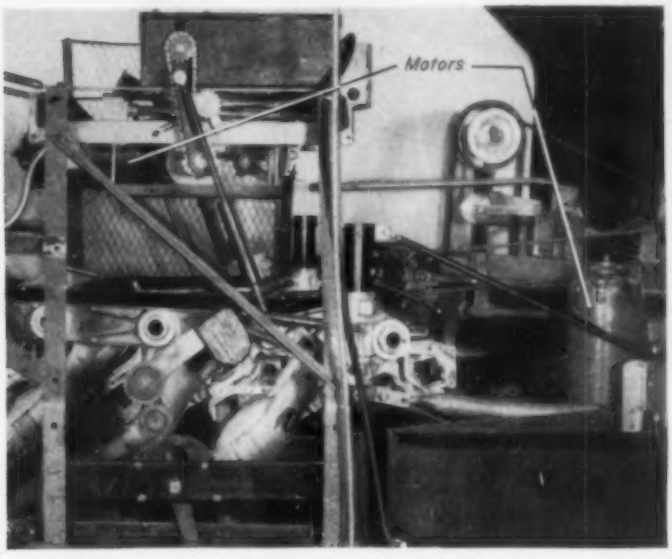


SEVERE SHOCK is isolated from the machine frame by spring mounted shock absorbers. One of these is, in turn, connected to a starting switch which is actuated by the release of the spring, not by the compression. Thus, when a ball hits the ball cushion, the shock absorber is first compressed and then released, starting the machine cycle.

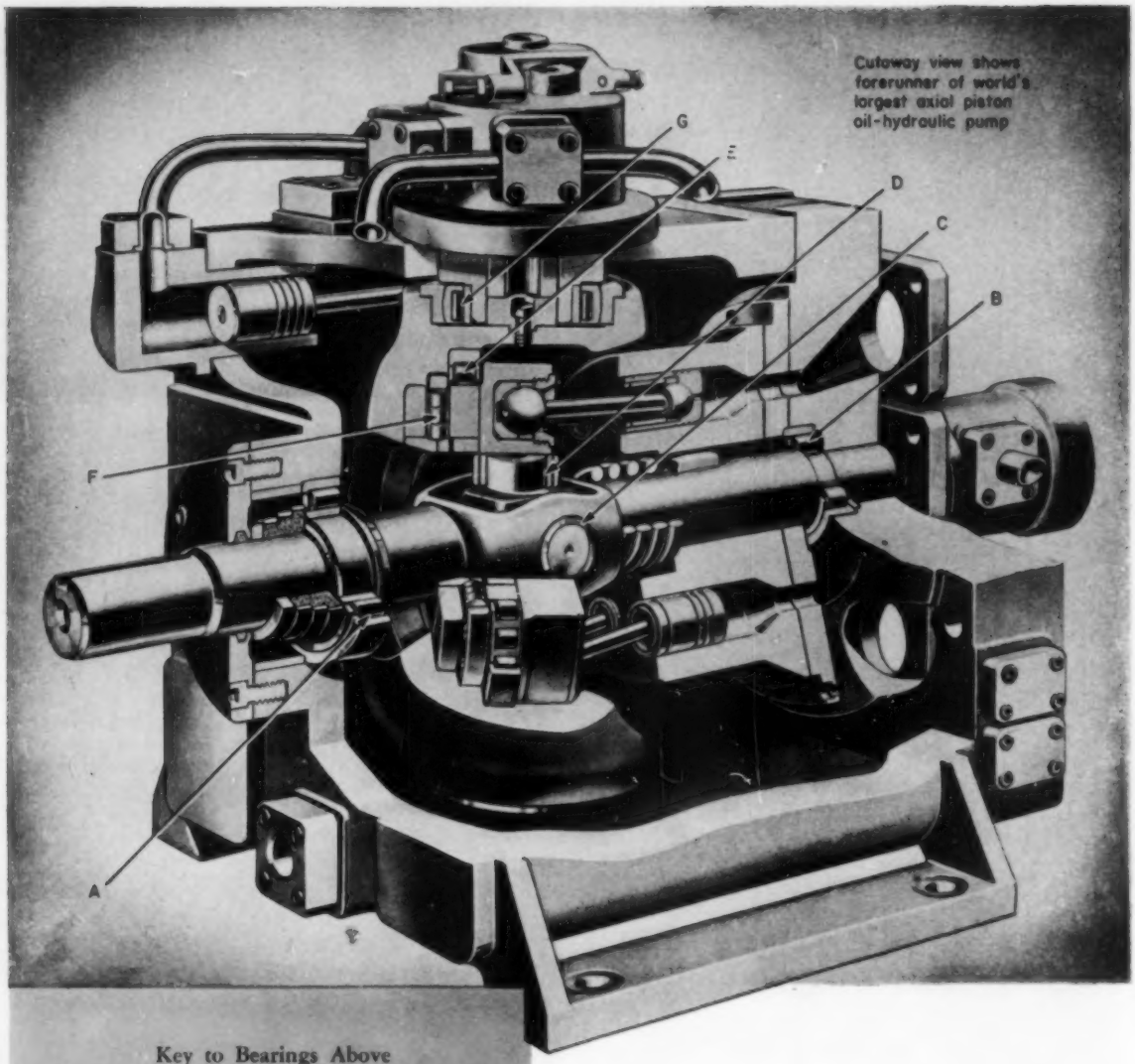




MECHANICALLY ACTUATED SWITCHES and multi-contact relays constitute the major elements in the control system. This minimizes maintenance, simplifies adjustment. The cam systems shown in these two views control the machine's operations. Group (A) control the sweep cycle, and group (B), the principal motions of the machine.



TWO OF THE GEARHEAD DRIVING MOTORS are equipped with an electric brake and hand crank. The brake, of course, insures proper positioning. The crank can be used to manually check operation of the various assemblies after installation, to back up operating members in case of a pin jam, and to simplify cam setting adjustment. Use of these driving motors point up the underlying theme in the entire design: Keep all operations as simple as possible and design the major elements for quick adjustment in the field. For example, the entire table can be pulled out in approximately 15 minutes, by simply removing seven bolts and disconnecting three electrical connections.

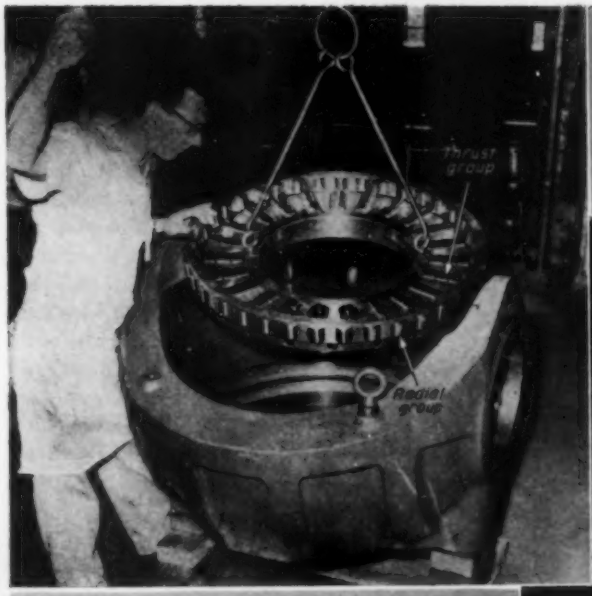


Key to Bearings Above

Designation	Loading	Amount of Loading in Tons
A — Case roller bearing	radial	44
B — Valveplate roller bearing	radial	6
C — Universal joint shaft bearings	radial (oscillating)	27
D — Universal joint trunnion block bearings	radial (oscillating)	27
E — Main thrust bearing	radial	127
F — Main thrust bearing	thrust	127
G — Tilt box trunnion bearings	radial (oscillating)	80

A Look At

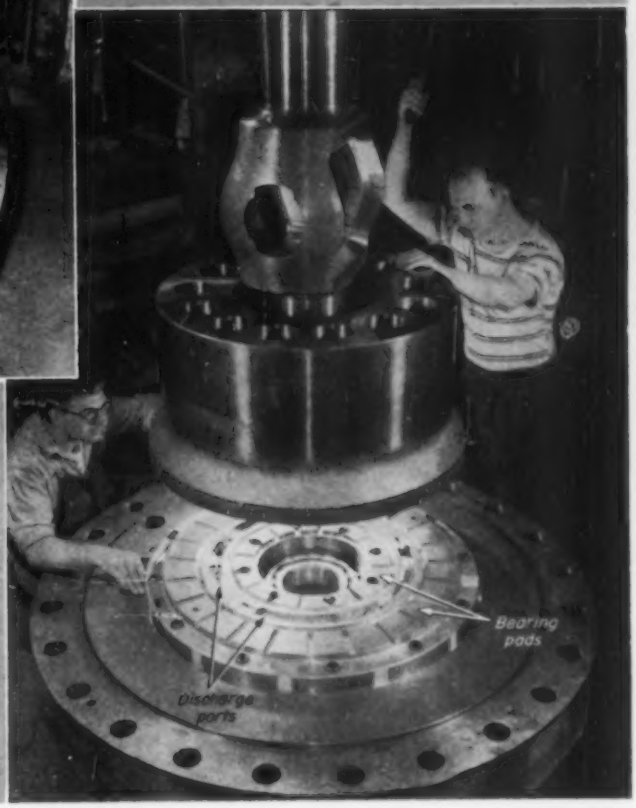
In the design of the two 20 ton oil-hydraulic pumps which are to operate the reciprocating saddle of the new tube reducer being built for the Tube Reducing Corp. (see *Product Engineering*, Sept. 1953, pp 148-151), engineers of the Waterbury Tool Division of Vickers, Inc. paid special attention to the bearings required. Bearing design was based not only on the operating pressures and delivery, but also on the unusual reversing feature of the pump. In every two seconds, the pump reaches full discharge of 2300 gpm in one direction, reverses to full output in the opposite direction and returns to zero delivery. As a result, design of all components—



Assembly Views Show Relative Sizes of Bearings Required

(ABOVE) Illustration shows the main thrust and radial bearing groups being lowered into the tilt box. Bearings required over 2600 calculations to arrive at the size and shape required.

(RIGHT) Hardened steel cylinder barrel being lowered onto the bronze valveplate. Barrel rotates against the valveplate at 400 rpm. Inner and outer bearing pads prevent scoring and excess wear.



Hydraulic Pump Bearing Loads

especially the bearings, had to be carefully engineered for the stresses produced by this reverse loading.

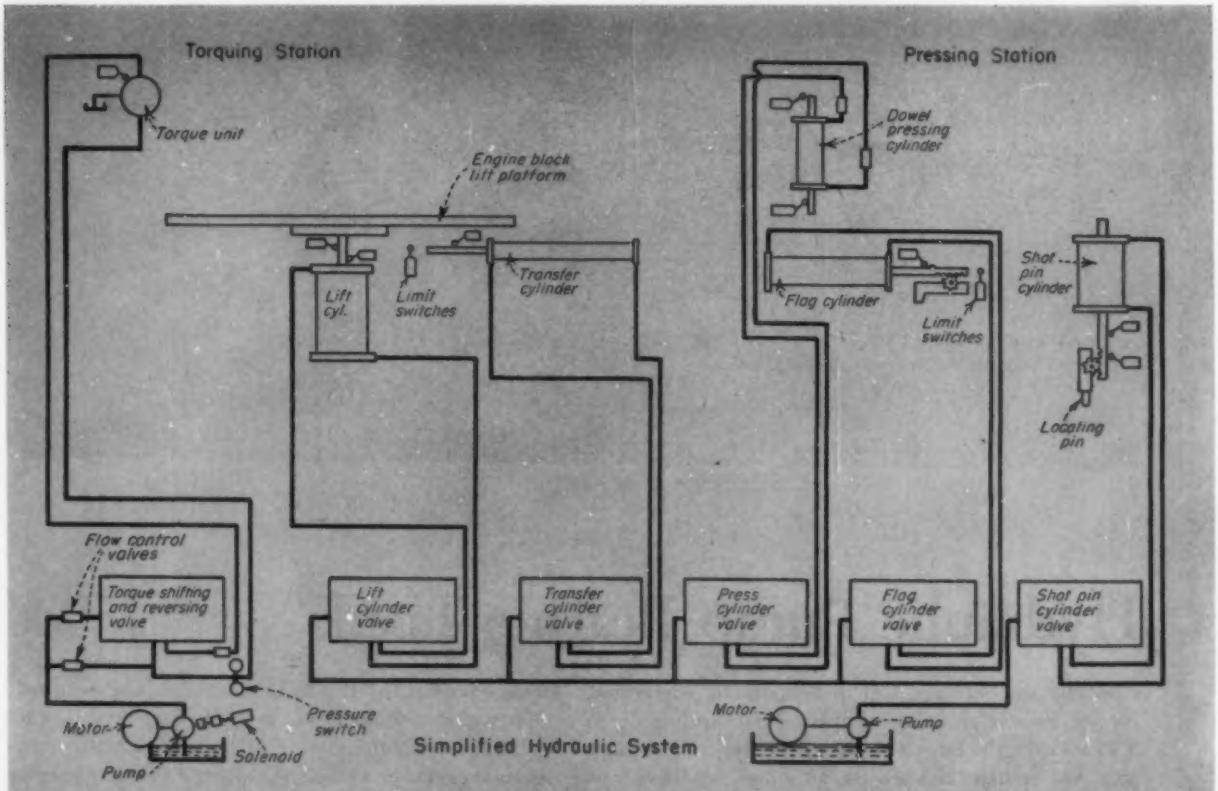
Previously, the largest pump of this type was a 1000 gpm, 540 hp unit. The new design jumps the delivery to 2300 gpm at 3000 psi, transmitting up to 4000 hp. In designing for the larger pump, most of the bearings were calculated from previous experience with the necessary larger bearings selected for the anticipated loadings. Only two bearings required an entirely new design approach—the main thrust and radial groups. For these bearings, the original work on thrust and radial roller types was correlated with experiments based on extensions of the Hertz equation for the larger unknown size required.

Considerable thought was given during the design to obtaining maximum cooling effect. To maintain optimum temperatures within the unit for bearing operation and hydraulic performance, the pump housing is completely filled and circulated with oil under pressure. Grooving on the valveplate, shown in the figure at right, plus the direction of oil circulating around the main bearings and through the housing contributes to the desired cooling effect. Continuous duty applications operating at high pressures generally require the use of heat exchangers to prevent excessive temperatures.

Hydraulic Drive Design Gives

Basing their design on the maximum use of standard purchased parts, the Hautau Engineering Co., Ferndale, Mich., went completely to the use of hydraulics to build into their automatic nut torquing machine a torquing sensitivity as low as 2 percent of values ranging from 35 to 120,000 in.-lb. Designed specifically for automatically tightening the ten main bearing cap screws of a V-8 engine block, the new machine overcomes the principal objection to present methods—the problem of maintaining a high-level quality control standard.

The machine is completely hydraulic in its operation. Dowel pressing, performed on the unit's auxiliary head, is done by hydraulic cylinders. Tightening of the bearing fasteners is accomplished by fluid motors geared to individual socket spindles. Transferring, locating and positioning of the block from one station to the next is obtained by hydraulic cylinders. Most unusual feature in the design is the switching from low pressure high volume oil flow to high pressure low volume to first quickly run down the cap screws and then accurately apply the desired torque. If any spindle fails to torque to a specified value, or if an untapped hole or misthreaded bolt is encountered, the machine will auto-



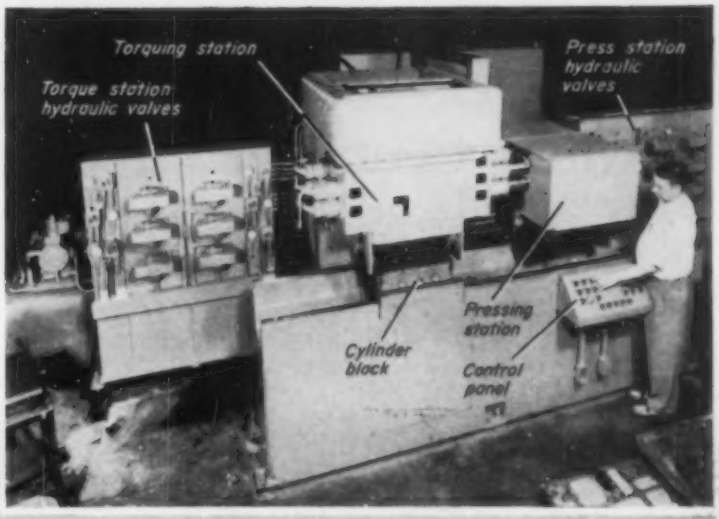
HYDRAULIC DIAGRAM shows the general arrangement of hydraulic components and control elements for the automatic cycling of the dowel pressing and nut torquing operations. Note that the pressing cylinders, there are 10, are all operated by the same hydraulic valve. Each of the ten torque units has its own valve for close control of the tightening operation. Extensive use is made of limit switches in the system, many being tied together in series to insure completion of one operation.

PRECISION TORQUING is obtained by first running the motor at low pressure and low speed until the rotating spindle sockets have properly engaged the cap screw heads. Engagement fully depresses a feeler rod resulting in a larger volume of oil being

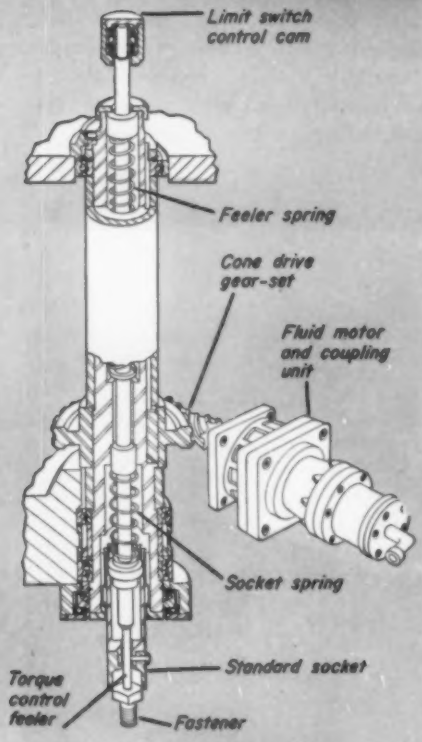
Machine High Torquing Sensitivity

matically stop, warning lights indicating the faulty bolt.

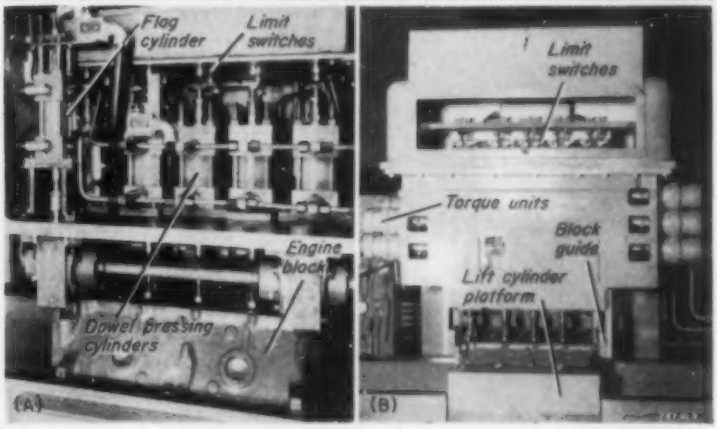
Another important feature of the design of this 20 ft long, 11 ft deep and 8 ft high machine is the emphasis on maintenance ease and accessibility. Besides using standard purchased parts, the hydraulic valves, motors and piping are all exposed and centrally mounted to facilitate continuous visual inspection.



ANOTHER LINK in the completely automatic factory is illustrated by this assembly-line nut torquing machine. Designed for a V-8 automotive engine block, the unit mechanizes the pressing in of ten $\frac{1}{4}$ in. dia bearing cap dowel pins and the tightening of the ten $\frac{1}{2}$-13 bearing cup screws, the complete cycle taking only 24 sec.



directed to the motor. When the screw is within $\frac{1}{16}$ in. of depth, the feeler rod contacts a limit switch to immediately direct a high pressure low volume oil supply to the motor. At the selected torque setting, the motor is stalled out and reversed.



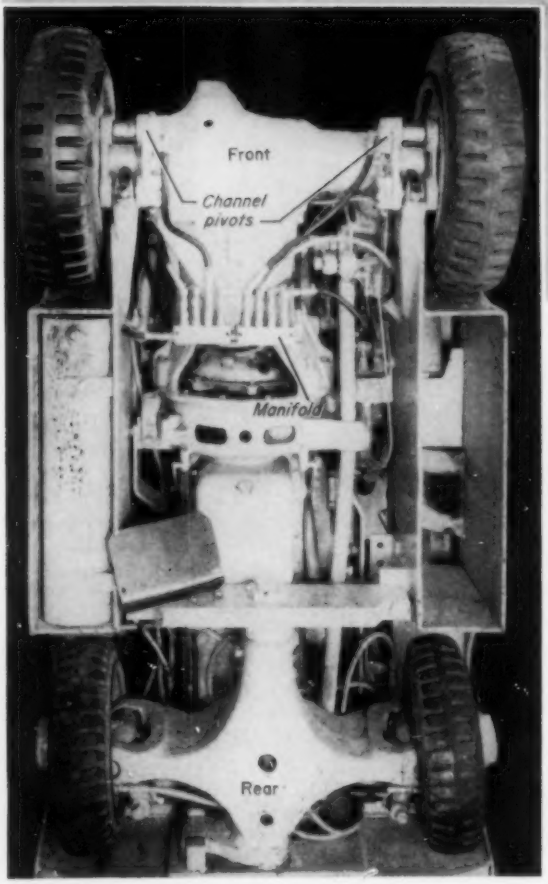
(A) Upon pushing the start-cycle button, the engine block is moved under the pressing head and accurately positioned. Dowels are then hydraulically pressed to depth, with an interlock system to assure completion of the dowel pressing cycle before the block is moved.

(B) At the torquing station, the block is hydraulically lifted to engage the slowly rotating spindles, the vertical guide cam surfaces accurately locating the head. The bearing cap screws are run down and then tightened to the desired torque. Limit switches shown act to shift the hydraulic units from low to high torque.

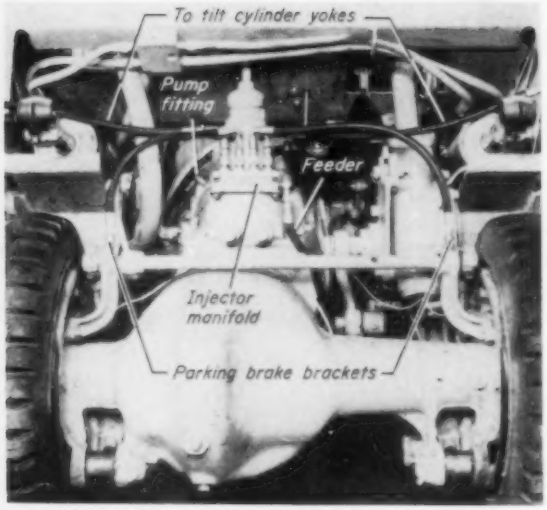
Fork Lift Trucks Adopt Centralized Lubrication

Working with engineers of the Lincoln Engineering Co., St. Louis, Mo., Yale and Towne Mfg. Co. has come up with an optional automatic lubrication system for their line of gas and electric fork lift trucks that is designed to deliver—within 45 sec—a predetermined amount of lubricant to each of 26 bearing points. Looked upon as a primary maintenance investment, the new system is aimed at reducing three troublesome truck operating expenses: labor, out-of-operation and overhead. Lubrication-wise, the centralized design insures a constant lubricating cycle while guarding against over and under delivery.

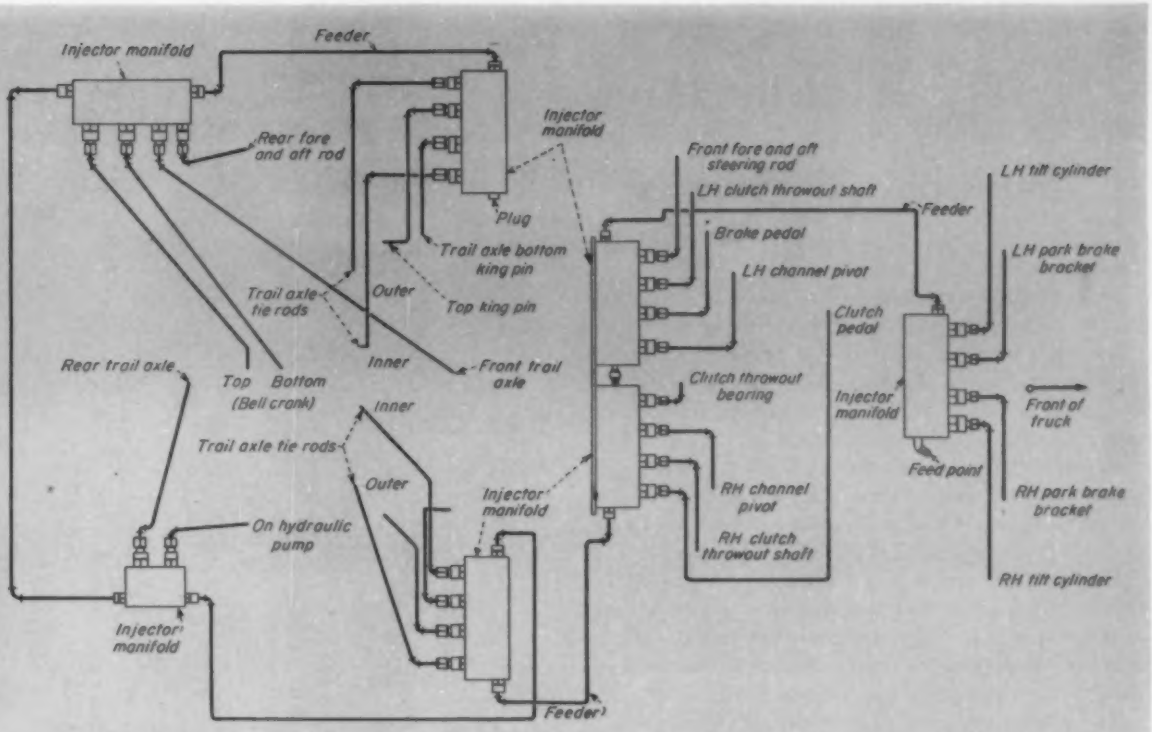
The system consists of a primary, 4-unit injector manifold feeding a series of secondary distribution manifolds mounted close to their respective lubricating points. Lubricant supply is furnished by a manually operated pump at a pressure equal to the highest pressure fitting in the circuit. With each fitting having its own injector valve and the valves, in turn, being individually adjusted for the proper amount of lubricant per cycle, the entire lubricating operation is simply a matter of raising the system to a predetermined pressure sufficient to unload and load each valve.



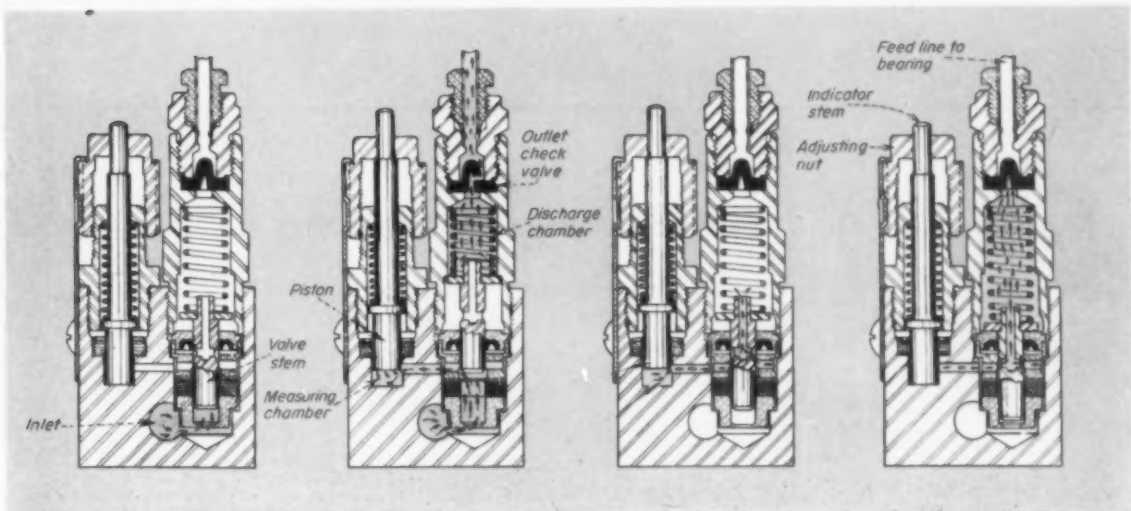
COMPLETE UNDERCARRIAGE VIEW of fork lift truck shows an 8-unit injection manifold mounted below the transmission housing, and lubrication channel trunnions. Manifolds are located as close as possible to the lubrication points to keep hose lengths to a minimum between injectors and fittings, thereby keeping system as simple as possible.



FRONT END VIEW SHOWS the main injection manifold which is located behind the channel assembly at the base of the clutch lever housing. Note the fitting to which the grease pump is attached for cycling the system. Hoses which are shown lying loose are connected to the tilt yokes when the channel is mounted.



SCHEMATIC DIAGRAM of the centralized lubrication system which is currently being designed into Yale and Towne fork lift trucks. Diagram shows relative location of system components on truck chassis.



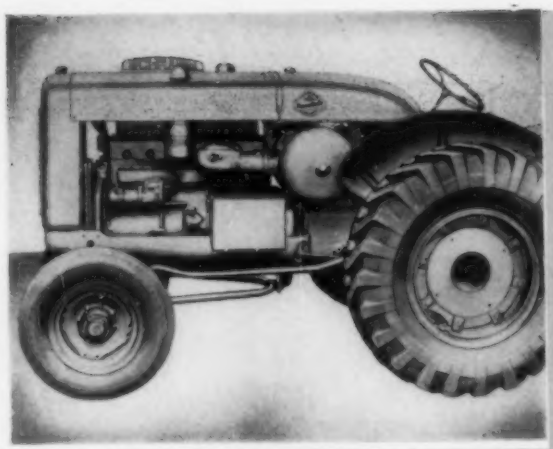
HEART OF THE LUBRICATION SYSTEM are the manifold grouped injector valves which are adjustable from practically one drop to 0.004 oz delivery per cycle. Cross-section sequence illustrates their operation. Lubricant under pressure from the pump enters the injector inlet forcing the delivery valve stem up, at which time material in the delivery chamber is forced through the check valve into the feeder line. Also, a quantity of lubricant is fed into a measuring chamber raising a spring-loaded piston. When the delivery cycle is completed, spring pressure forces the piston down transferring metered lubricant into the delivery chamber loading the injector for the next cycle.

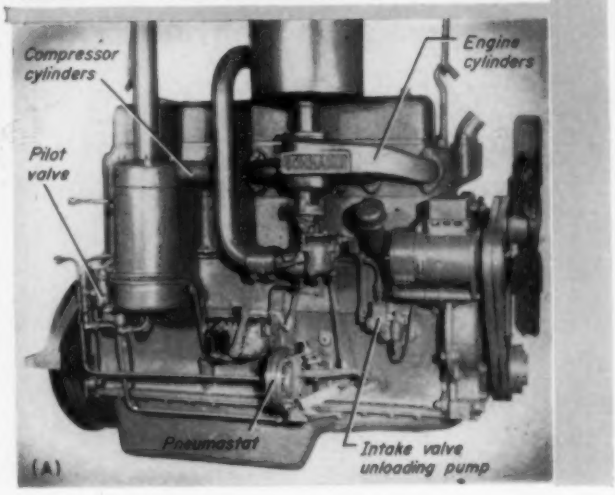
Wheel Tractor Has "Built-in" Air Supply

By functionally splitting an engine block into compressor and engine sections, and then using the horsepower developed to also drive a heavy duty tractor transmission, Schramm, Inc., West Chester, Pa., has designed a self-propelled air compressor for applications requiring tractor mobility plus high air capacity. The versatility of the unit is further extended by bolting a strong cast steel frame to the rear axle and carrying it on the front axle. This feature permits the use of a wide range of separately attached auxiliary equipment.

Heart of the design is a combination engine block that is half engine, half compressor. Compressor end operates as a single stage unit; the other end as a three-cylinder 4-cycle gasoline engine. Pistons are identical in design, stroke, diameter and composition.

To facilitate operation as a tractor, the air compressor cylinders are hydraulically unloaded. To prevent constant loading and unloading between half and full capacity, an air governor has been specially designed. This unit permits the engine and air compressor to operate at the speed necessary to produce the amount of air being consumed by the air tools and other devices connected to the receiver.





Italian Motor Scooter Designed for Modern Living

Some of the major design features contained in the construction of a new mass-produced motor scooter recently developed by Ducati Co., Bologne, Italy. Illustrations on the opposite page show the scooter from two views, head-on and with engine cover removed.

TRANSMISSION. Biggest feature of the new vehicle is the adoption of a double-stage torque converter instead of the conventionally used gear box and clutch drive. Converter is directly driven from the engine shaft through a specially designed flexible coupling. Transmission of power from the converter output shaft to the rear wheel is by a spiral tapered gear.

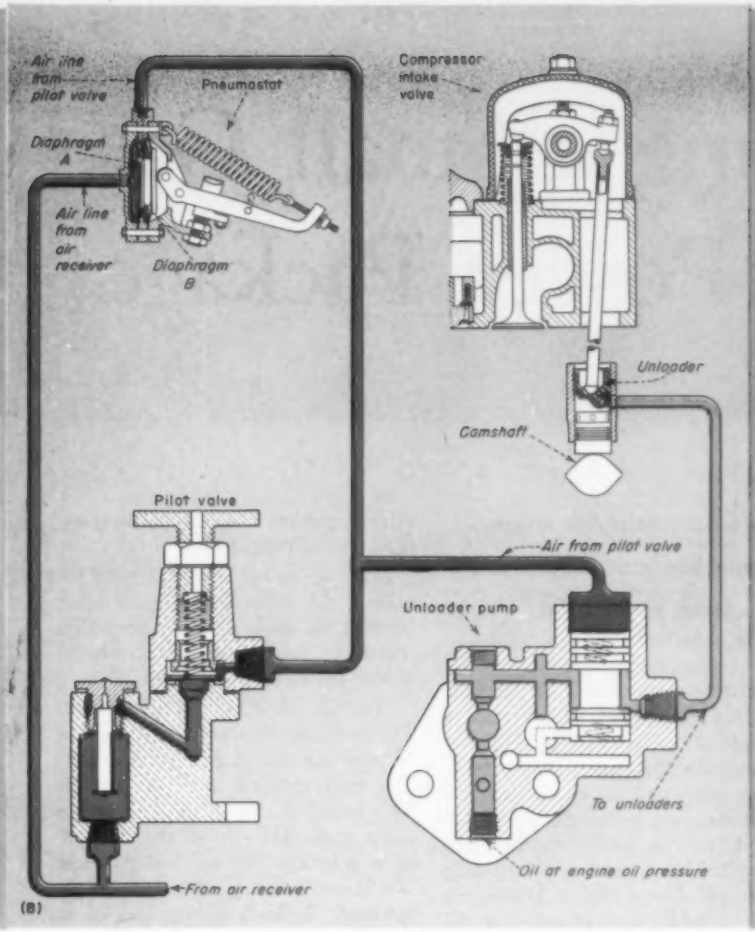
ENGINE. Power is supplied by a 4-stroke single horizontal cylinder engine having a 2.3 in. bore and a 4.7 in. stroke. Capable of developing over 7.5 hp, the engine features automatic ignition advance. Pressure lubrication is supplied to both the crank shaft and rocker arm boxes. Combustion chamber is semi-spherical, the overhead valves for which are operated by push rods from a cam shaft in the base structure.

WHEELS AND BRAKES. The vehicle uses grooved rimmed wheels, 2.45 x 10, designed for overhanging mounting. Brakes consist of segmented rubber blocks operating against large diameter ribbed drums. Both wheels are completely interchangeable.

SUSPENSION. Both front and rear suspension consist of self-damping swinging arms plus rubber blocks which form the traction elements. At the rear, the converter box is pivotted on the engine housing permitting the entire converter assembly to operate as a swinging arm for the suspension.

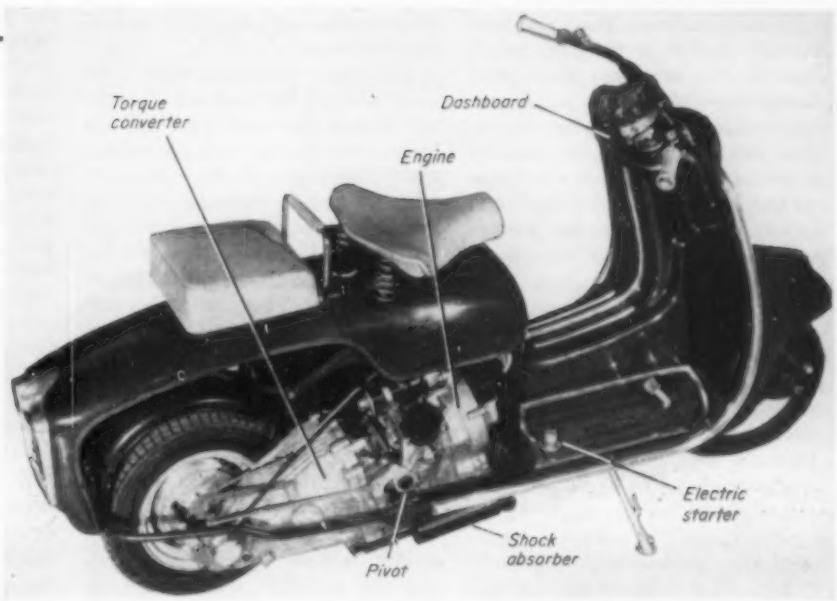
CONTROLS. A speedometer and three-positon inition lock key make up the dashboard. Right handgrip, both left and right grips are mounted on flexible antivibration bearings, controls motor acceleration. Right hand lever is used for transmission locking for motor braking and starting without a battery, left lever for the front wheel brake. Switches control the headlight and direction turn indicators.

GENERAL INFORMATION. Fuel consumption is said to be 95 miles per gallon; top speed about 50 mph. A foot operated switch is used for electric starting, the starting motor being geared to the motor flywheel by a free wheeling pinion. To increase the vehicle's dependability, a spare tire and necessary repair tools are accessibly recessed in the rear structure.



(A) POWER PLANT on the Pneumatractor. The three cylinder gasoline engine end develops 36 hp, sufficient to power the compressor or tractor, either independently or in combination. Actually, only difference in construction between both ends is in camshaft.

(B) PILOT VALVE and compressor unloading arrangement. When air receiver pressure hits a pre-set figure, air pressure lifts a spring loaded disk in a pilot valve which then directs the air pressure to an unloading pump and to a differential diaphragm unit regulating the engine speed. At the pump, air forces a piston down to allow engine oil to be pumped into a valve unloading section. Oil forces two small pistons apart extending the push rod to keep the valve off its seat.



Picking a Small Gas Engine Power Package

Standard ratings and procedures for internal combusion engines have become a valuable tool for choosing the basic engine and the accessories that are best suited for a given application.

LEO LECHTENBERG
Development Engineer
Briggs & Stratton Corporation

IN CHOOSING A SMALL—up to about 8 hp—single cylinder gasoline engine, the first question is: how much horsepower does the job require and what engine horsepower rating should be selected. To simplify this last problem, the Internal Combustion Engine Institute has established standard ratings and procedures. The horsepower normally quoted is the peak power attained at a rated operating speed during laboratory operation. Engine manufacturers guarantee that all engines will produce not less than 85 percent of this horsepower when new and that after engines are fully broken in, they will develop not less than 95 percent of the rated peak horsepower.

These horsepower ratings are based on standard operating conditions, namely, sea level at 60 F atmospheric temperature. Allowance must be made when the altitude and temperature is different. Power decreases approximately 3½ percent for each 1,000 ft above sea level and one percent for each 10 deg above 60 F. For example, a manufacturer rates an engine 2.0 hp at 3,600 rpm. This means the engine will develop not less than 1.7 hp (0.85 × 2.0) when new for the standard temperature at sea level. At 5,000 ft and 85 F, the power will decrease a total of 17½ percent (5 × 3½), for altitude plus 2½ percent, (85 — 60)/10 for temperature. The power loss would therefore be 20 percent of 1.7 or 0.34 hp. The power available from a new 2.0 hp engine would be only 1.36 hp, (1.7 — 0.34), at 3,600 rpm; and after the break-in period, it would be at least 80 percent of 1.9, (0.95 × 2), or 1.52 horsepower. Fig. 1 is a typical power curve based on standard test conditions.

The next question is: what is the desired life of the product? Will the unit be used day in and day out, a few hours a day or less than 50 hours a year? Normally, if the anticipated usage is several thousand hours, a speed somewhat lower than 3,500 rpm is desirable. In general, the lower the operating speed, the longer the life of the piston rings. But, very satisfactory life can still be expected if the unit is operated at the peak rated speed, if care is taken that the life of the engine is not adversely affected by dirt and dust getting into the engine. For continuous duty, constant load applications, such as generator sets where maximum reliability and life are required, it is often wise to specify a Stellite exhaust valve with rotators and an austenitic intake valve to achieve maxium valve life when using highly leaded gasolines.

Once the power and load cycle are known, the equipment designer must consider the many accessory items that contribute singly and collectively to overall product performance.

Method of Power Transmission. The first consideration is the method of coupling the engine to the unit. The most common drive is through Vee belts. If the engine is to be direct connected—as in the case of some generator sets and water pumps—a flange-mounting engine should be specified. In such applications, it is common to mount the generator or pump housing directly on the crankcase of the engine to facilitate alignment. In many cases, the rotor of the generator is mounted directly on the taper end of the engine crankshaft without an outboard bearing. If an outboard bearing is used, extra precaution is required to see that this third bearing is in accurate alignment with the crankshaft bearings. Otherwise, failure of the shaft due to fatigue will result. Another difficulty when mounting a generator with an outboard bearing is the fact that these units are sometimes handled roughly, and in such handling the unit may be distorted or bumped so that the third bearing is no longer in alignment with the crankshaft bearings.

A wide variety of couplings are available, ranging from the "Oldam" style coupling to the spring steel type coupling. The power stroke of the engine imposes a heavy load on the

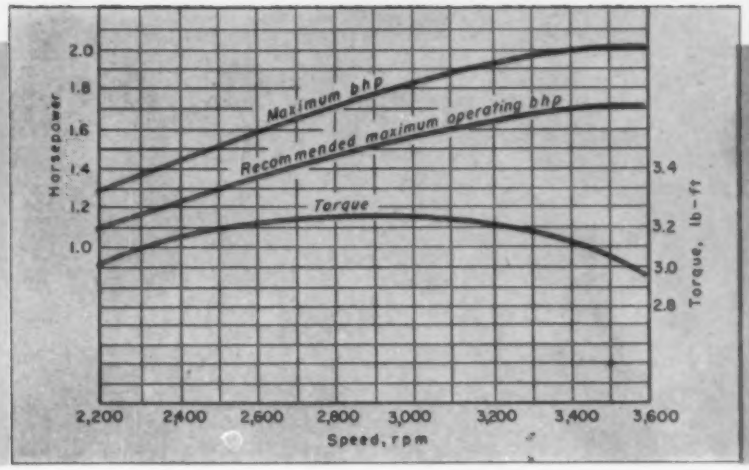


Fig. 1—Power curves for single-cylinder 4-cycle gasoline engine rated two horsepower at 3,600 rpm. Data have been corrected to standard conditions at 60 F at sea level pressure as specified by The Internal Combustion Engine Institute. Duty cycle of a given application determines amount of power taken from engine, and its effect on engine and accessory life, as well as the overall operational costs.

coupling. For this reason it is desirable to use a large factor of safety in selecting couplings to be used with single cylinder internal combustion engines.

Both centrifugal and manual clutches are becoming increasingly popular. A clutch should be used between the engine and the driven unit if it is difficult to start the engine with the driven unit attached. And with self-propelled vehicles, a clutch is mandatory to allow the engine to idle when the driven unit is not moving.

Centrifugal clutches are actuated by the centrifugal force of weights in the clutch. They normally are completely disengaged at some predetermined speed, below 1,800 rpm, for example. As speed increases to approximately 2,000 rpm, the clutch engages, due to the increase in centrifugal force on the clutch weights. It is sometimes difficult to start the engine without speeding it up enough to engage this type of clutch. On some applications this is no problem, while on other units this condition might be dangerous. With manual clutches there is no danger of engaging the clutch if the speed of the engine is accidentally increased.

If the equipment functions best at less-than-crankshaft speed, it may be advantageous to specify an engine with a built-in gear reducer. Units of up to and including 6 to 1 reduction ratio are usually available from the engine manufacturer.

Fuel Systems. In general, the following types of carburetors are available: (1) suction feed, (2) float feed with gravity flow from overhead fuel tank, (3) float feed with fuel pump, and (4) float feed for operation on kerosene. Table I lists the key selection factors.

The suction feed carburetor is used primarily where simplicity and cost are prime considerations, and is commonly specified for smaller lawn mowers, small garden tractors, and related equipment.

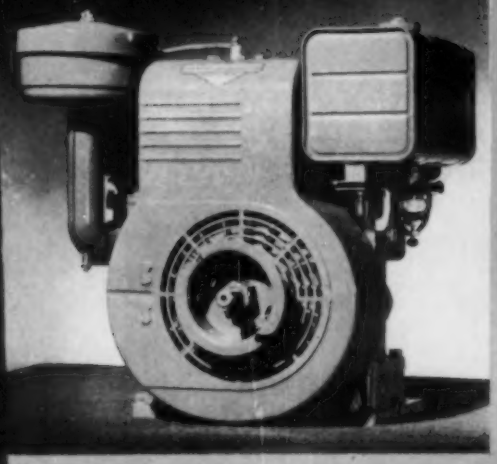
From the standpoint of performance and power, the float feed carburetor offers an advantage: Its air-fuel ratio characteristics are usually more constant throughout a wide range of operating conditions than are those of the suction type. In addition, the power output of an engine of the same cubic-inch displacement is generally about 25 percent greater with a float feed carburetor.

Again in the interest of simplicity and cost, when a float feed carburetor is used, a gravity feed fuel tank is specified. The tank usually has sufficient capacity for an hour or two of operation at full throttle or several hours at part throttle. If the operational period is exceptionally long, a separate tank of extra large capacity can be used. Such a tank can be mounted for gravity feed, but to simplify mounting it is usually placed below the carburetor level. A fuel pump must then be specified, and for ease of priming, the tank should be mounted not more than three feet below the level of the pump.

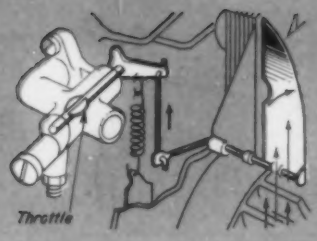
In some foreign countries, the high cost of gasoline necessitates the use of kerosene (except during starting). For operation on kerosene, the carburetor float chamber has a drain, and the fuel line is equipped with a shutoff valve and primer. With the shutoff valve closed, the carburetor float chamber is drained of kerosene and filled with gasoline through the primer. The engine is started on gasoline and, by the time the fuel in the float chamber is used up, the engine is hot enough to

Table I—Key Factors in the Selection of Fuel Systems

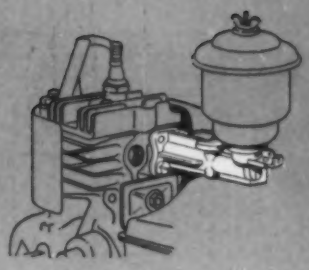
Characteristic	Suction Feed Carburetor	Float Feed Carburetor		
		Gravity Feed	Fuel Pump	For Kerosene
Max simplicity, low first cost	X			
Max power on given engine		X	X	X
Max performance		X	X	X
Max fuel economy			X	
Max performance plus portability		X		



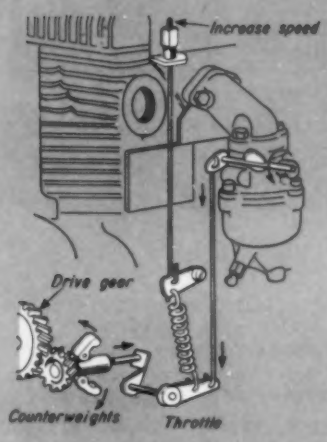
Today an increasing number of products require the use of small single cylinder gasoline engines. These products include lawnmowers, snow plows, generator sets, water pumping systems, tractors, a wide variety of farm equipment, construction machinery and railroad maintenance equipment. Assembly of the "power package" is not merely the selection of the basic engine. The various accessories, chief among which are the governor, carburetor, controls, starter and air filter, must also be chosen for the application.



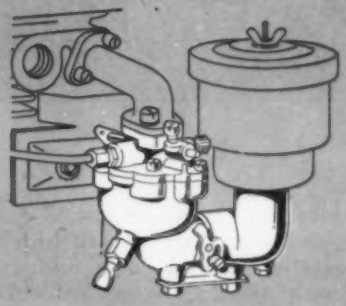
Pneumatic Governor



Suction Feed Carburetor



Mechanical Governor



Float Feed Carburetor

operate on kerosene. The shut-off valve is then opened, allowing kerosene to flow from the tank to the carburetor.

Governors. Two types of governors are available: (1) Air vane or pneumatic, and (2) mechanical or flyball.

The air vane governor is energized by the air stream from the cooling fan, which therefore performs a dual role. The vane pressure is balanced by the governor spring. As the engine accelerates, the increasing air velocity boosts the pressure on the vane. When vane pressure overbalances the governor spring, the throttle is closed and engine speed decreases.

The pneumatic governor is less costly than the mechanical type and should be used when accurate speed control is not essential. A variation of approximately 400 rpm can be expected between the speed of the engine at no load and at full load operation.

With a mechanical governor, it is possible to hold this variation in speed within much closer limits. For this reason, the mechanical governor should always be specified for generator sets where any change in speed affects the voltage and the regulation of the generator or for other equipment requiring very close regulation.

This flyball-type governor is energized by the centrifugal force of weights pivoted on a gear rotating at high speed. These assemblies are usually inside the engine crankcase and are lubricated by crankcase oil, thereby reducing wear and servicing problems.

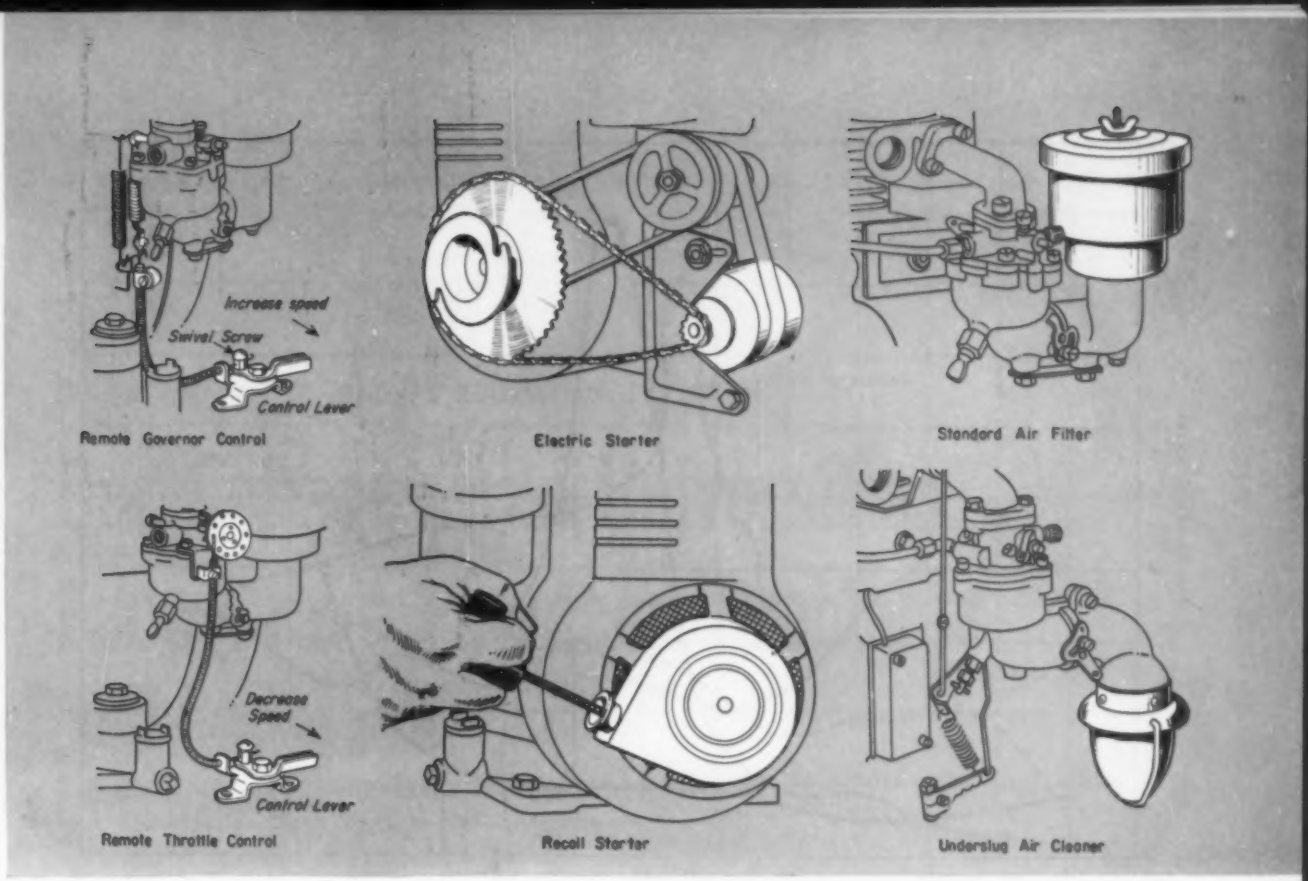
Starters. There are four types of starters: (1) Rope, (2) recoil, (3) hand crank and (4) electric. All are not available on each model engine, but with each model there is usually a choice. The type used depends a great deal on individual taste and preference, as well as on accessibility in a given application. From the standpoint of simplicity, low cost and ease of starting, the rope starter is most commonly specified. Recoil starters on engines up to 2½ hp are rapidly becoming more popular on all types of equipment.

Controls. Various types of speed controls are available for small gasoline engines. The most popular is the thumb nut adjustment of the governor speed. By this method, the governor speed of the engine can be varied by turning a nut on the control rod.

Remote speed regulation can also be achieved by either governor or throttle control. With the remote governor control, the speed of the engine is adjusted through movement of a remote control lever at some distance from the engine. For any fixed position of the lever, the engine speed remains constant regardless of the load.

When remote throttle control is used, all but the top (governed) speed are controlled through a lever on the throttle. For any fixed position of the lever, engine speed will increase if the load is removed, decrease if the load is increased.

Mounting. When a single cylinder engine is used, it should be mounted so as to keep vibration at an acceptable level throughout the entire operating range. Since each driven unit is peculiar as far as vibration characteristics are concerned, in no case should the mounting be in resonance within the operating speed of the unit. Experience indicates that if no part of the engine vibrates at a root mean square velocity greater than three inches per second, the mounting is satisfactory. If the velocity exceeds this figure, fatigue may cause parts to fail prematurely. A vibration velocity of approximately one inch per second is recommended.



If, after the engine has been mounted, the vibration level is not satisfactory, and some part of the unit is in resonance, the designer can follow one of two courses. By making the mounting more rigid, he can raise the speed at which the unit goes into resonance; or by softening the mounting, he can reduce the resonant speed. The second method has one big disadvantage: the unit may again go into resonance at some harmonic or multiple of the new resonant speed. For this reason, it is usually more desirable to reinforce the mounting so that the resonant speed is greater than the operating speed.

Careful attention should be given to provide adequate ribbing or strength from the engine mounts to rigid members of the driven unit. The reinforcing members of the frame should be close to the mounting bolts, as illustrated in Fig. 2 (A), because center reinforcement, Fig. 2 (B), would induce oscillation about this single member. With cantilever mounting, Fig. 3, mounting supports should be strong enough to remain out of resonance. In some applications, a supplementary brace is necessary to prevent vibration.

To show how the mounting can affect vibration characteristics, one engine was checked in four different applications. The curves in Fig. 4 show the horizontal vibration velocity at the

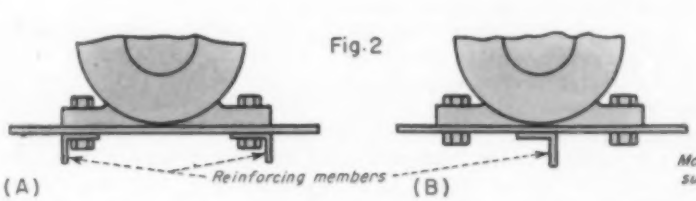


Fig. 2—Reinforcements such as ribbing should be designed for maximum strength between engine and main assembly. Wide spacing of ribs (A) is recommended; single center rib (B) is not desirable because engine would tend to oscillate with the single reinforcing member as the pivot point.

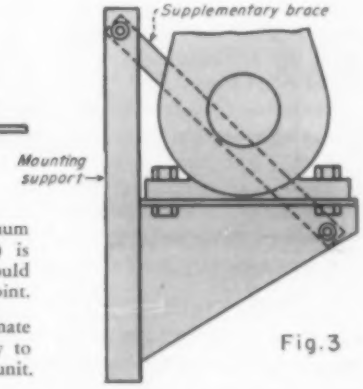


Fig. 3—Cantilever engine mounting requires supports that will not resonate in engine operating range. Supplementary bracing is sometimes necessary to produce vibration characteristics that insure resonance-free operation of unit.

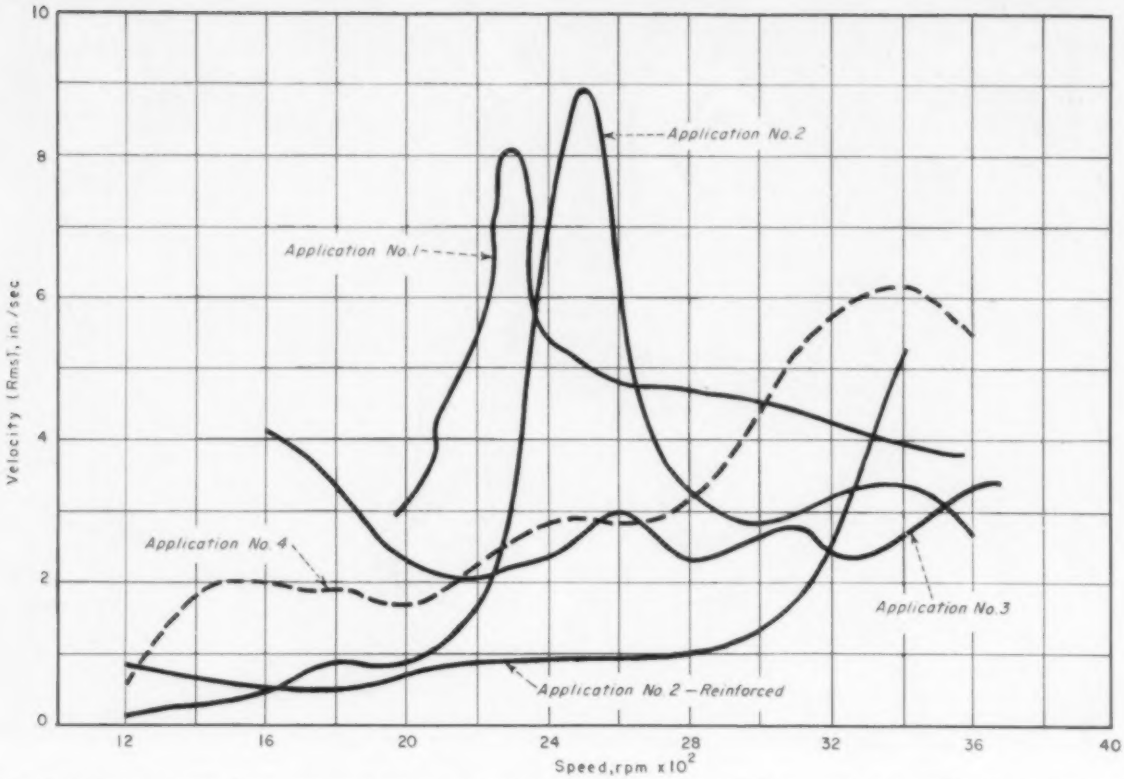


Fig. 4—Vibration curves shows horizontal velocity at cylinder head of gasoline engine mounted on four different applications. Curve for "Application No. 2—Reinforced" shows how properly placed reinforcing member reduces rms velocity of vibration.

cylinder head. In application No. 2, the mounting was in resonance at approximately 2,500 rpm, causing a peak velocity of about 9 in. per second. Since the maximum operating speed of the particular application was 2,600 rpm, this degree of vibration was objectionable. By placing a $\frac{1}{8}$ by 2 in. reinforcing member on edge below the mounting feet, the vibration characteristic was lowered, as shown by the curve marked "Application No. 2—Reinforced". Reference to this curve shows that, at all speeds up through 2,800 rpm, the vibration velocity is less than one inch per second. It should also be noted that the reinforced mounting would probably resonate at about 3,600 rpm, indicating that the amount of reinforcing was sufficient to establish the resonant period well above the operating speed.

The instrument used for these vibration studies has a range of rms velocity from 0.010 to 100 in. per sec and a displacement range of 0.001 to 1.0 in., total. These pick-ups are readily applied for locating exactly which part of a mounting should be reinforced.

Environment. Dirt and dust are other factors to consider when mounting a small gasoline engine. The air cleaner should be mounted as high on the engine as possible so that the amount of dust going through the intake system is held to a minimum. Dust taken in through the crankcase breather is also important, especially in extremely dusty environments. By venting the breather into the intake system, the breather uses air that has already passed through the air cleaner.

If an engine is to operate in an environment where a large amount of grass clippings, chaff and the like are apt to get into the blower housing, some means should be provided to keep this foreign matter from entering the cooling air stream. Otherwise, the cooling fins will become clogged, causing overheating and premature failure of the engine. Normally, a rotating screen at the entrance to the blower housing is sufficient.

In snow-plow applications, it is important to prevent fine snow from clogging the intake system. One solution is to route the intake air from an area around the muffler where snow would melt rapidly. This system has the added advantage of supplying some heat to the carburetor and so prevent freezing.

Special attention should also be paid to accessibility of items that have to be serviced. Typical among these "handy" accessories are: air cleaner, carburetor, spark plug, breaker points and condenser, fill and drain fittings on crankcase and fuel tank, and blower housing mounting screws.

Other articles published by *Product Engineering* on the subject of gasoline engines include: (1) "Which Engine Should Power your Equipment?" by Milbrath of Wisconsin Motor Corp. (Feb. 1953); and (2) "Two-Cycle Engines for Portable Power" by Krueger of Power Products Corp. (Mar. 1954). The first article considers the selection factors for one-, two- and four-cylinder air-cooled engines up to about 30 hp, while the second article is a comprehensive analysis of design and performance characteristics on portable two-cycle engines which are finding increased use.

FINANCIAL AID TO HIGHER EDUCATION

Our Colleges and Universities Face Grave Financial Problems

For the past decade the nation's colleges and universities have been caught in a destructive financial squeeze. It is particularly destructive for the independent, privately endowed institutions. Unless extraordinary measures are taken to relieve this squeeze, it promises to become progressively worse. To let it do that is to court a national disaster.

This is the first of two editorials devoted to the financial plight of our colleges and universities. This first editorial deals with the character of the problem, present and potential. The second will indicate some things that need to be done about it, and particularly what American business might do.

Enrollment Soars, Income Lags

In broad outline, the financial problem that afflicts our colleges and universities is simple. The demand for their services has increased rapidly, and promises to keep on increasing even more rapidly. At the same time, their financial capacity to provide these services has lagged behind, primarily because of price inflation.

Between 1940 and 1950, college and university enrollment increased from approximately 1⅓ million to 2⅓ million—about 75 per cent. Over the same period, the educational income of these institutions, measured in terms of its actual purchasing power, increased only about 64 per cent. Thus, at the end of the decade, our colleges and universities as a group had, on the average, about 6 per cent less to spend per student than they had at the beginning. Meanwhile, the rapid advance of science and technology had made a good college or university course a much more expensive operation than it was in 1940. Since 1950, the latest date for which comprehensive figures are available, the financial squeeze on our colleges and universities has intensified, largely because of another wave of price inflation touched off by the Korean War.

Among the colleges and universities, the independent, privately endowed institutions are particularly hard pressed. In terms of actual purchasing power, the independent liberal arts colleges are now spending at least 20 per cent less per student than they spent in 1940. Public institutions of higher learning, supported out of tax revenues, have managed to increase slightly their expenditure per student. Otherwise, the financial squeeze on higher education as a whole would be even more severe.

Why Independent Colleges Are Hit Hardest

The principal reason why the independent colleges and universities are so hard up is the shrinkage in their income from endowments. These endowments, created in other days by gifts of generous benefactors to help pay the expenses of higher education, have been hit hard from two directions. During the war and post-war years, the tax collector took so large a part of the incomes and estates of wealthy people that this source of endowments has been greatly reduced. Over the same period price inflation cut in half the purchasing power of the income derived from existing endowments. In 1940 income from endowments provided 26 per cent of the total income of the independent colleges and universities. By 1950 it provided only 14 per cent. The figure is still lower today.

The financial plight of the independent colleges and universities is directly reflected in the salary status of their teaching staffs. In mid-1952 a national survey showed that, after adjustment for the increased cost of living, the salaries of those holding full professorial rank in these institutions were 12 per cent lower than they were in 1941-42. Junior teachers, with the rank of instructor, fared somewhat better. In terms of actual purchasing power, their salaries declined only 2 per cent over the 12-year period, largely because there is more direct competition for their services from industry. Over the same period, the real wages of industrial workers increased 55 per cent.

Time Will Not Provide a Cure

The plight of the colleges and universities, which is shared in some degree by all parts of our educational system, is not one that can be left to time for a cure. On the contrary, the financial problems of our institutions of higher learning will be intensified in the years ahead by the pressure of rapidly increasing enrollments. Present prospects indicate that during the next decade college and university enrollment will increase by about one-third, or from 2⅓ million to over 3 million. The problem of increased enrollments will become particularly acute toward the end of this decade when the babies born during the great surge of population in World War II are ready to enter college.

Such an increase in population as that now in prospect can be a tremendous asset to the nation. It is still a truth, even though it is worn a bit thin by frequent repetition at commencement exercises, that a nation has no resource more valuable than the education of its people. And the better the education, the more valuable the asset.

But to realize this, our colleges and universities must have the financial strength to handle the increased enrollments that face them in the years ahead. This means that we must relieve our independent colleges and universities, in particular, from the financial squeeze in which they are now caught and make them full partners in the economic well-being of the nation. Some of the means by which American business might help achieve this will be discussed in a second editorial.

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Selection of Soft Solders and Fluxes

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ALMOST ANY TIN-LEAD SOLDER will bond with copper, iron, steel, nickel or zinc. But if a solder selection is to be tailored to a given design involving these metals or their alloys, the reactions that occur when tin and lead are alloyed should be understood.

The first consideration is the melting range for the solder. This property can best be studied by referring to a constitutional diagram, Fig. 1, based on a series of alloys chosen to bracket the temperature range under investigation. Cooling curves of the alloys establish two key temperatures—the point of incipient melting (Solidus) and the point at

● ● ● ***When a design requires metallic bonds that will not influence the properties of the metals being joined, it is as unwise as it is unsafe to state simply "solder" on a specification sheet or blueprint. The designer should know how the main variables—solder alloys, fluxes and base metals—affect the characteristics of a soft solder joint. Joint design is also important.***

which melting is complete (Liquidus). These two temperatures are then used as the basis for a series of curves from which the melting and freezing temperatures of any tin-lead alloy can be determined.

Referring to Fig. 1, there is only one alloy in the whole series that has a true melting point as possessed by a pure metal. This is the "eutectic" alloy containing 62 percent tin and 38 percent lead. The melting point of this alloy is 362 F, a remarkably low temperature when it is noted that lead melts at 621 F and tin at 450 F. Thus, if parts to be joined have a low melting point or are of such a nature that high soldering temperatures seriously affect their properties, the low-melting eutectic alloy can be used.

The diagram also reveals that the tin-lead alloys of 19.5 to 97.5 percent tin content begin to melt at 362 F. This fact is of value because it establishes the absolute maximum temperature at which any alloy in this composition range can be used. In practice, a safe working temperature for this group would be considerably lower because at 362 F the strength of the solder is zero.

Tin-lead alloys containing up to 19.5 percent tin begin to melt at temperatures varying from 362 to 621 F as shown by the line *AB* in Fig. 1. But since these values represent equilibrium conditions rarely prevalent in commercial operations, it is safer to assume that the limit of solid solubility of tin in lead for these operations is nearer 10 percent as shown by the dotted line *AR*. At the other end of the scale in the tin-rich area, the melting range is narrower. Alloys containing more than 97.5 percent tin begin to melt at temperatures varying from 362 to 450 F, as shown by the line *ED* in the diagram.

From these facts, a number of practical observations can be made. No tin-lead solder except the eutectic alloy has what is commonly called a melting point. Actually it is a melting range, the widest being 173 F for the alloy containing 19.5 percent tin.

When the temperature of the solder is in the area between the solidus and liquidus (*ABCDE* and *ACE* in Fig. 1), both solid and liquid are present and the solder has no strength. The length of time during which the solder changes from the liquid to the solid state when making a joint may vary from a fraction of a second to several seconds and depends on many factors such as composition and soldering temperature, as well as the temperature and cooling rate of the members being joined. Thus it is often necessary to hold the members firmly in a clamp or jig while the solder is cooling.

The constitution diagram also explains why wiping solders usually contain between 30 and 40 percent tin. The melting range of this group of alloys varies between 134 and 98 F. Although the plastic range is not the widest possible, the combination of good plasticity and moderate melting range is ideal for wiping.

The most practical use for Fig. 1 is in determining the appropriate alloy for a given application. For example: what tin-lead solder should be used for a joint exposed to temperatures up to 400 F? The diagram reveals that no solder containing between 19.5 and 97.5 percent tin will satisfy this condition. Likewise, alloys containing more than 97.5 percent tin are too close to the operating temperature. Therefore, a solder containing less than 17 percent tin would have to be used, and under the conditions mentioned, a tin content of between 5 and 10 percent would probably be suitable.

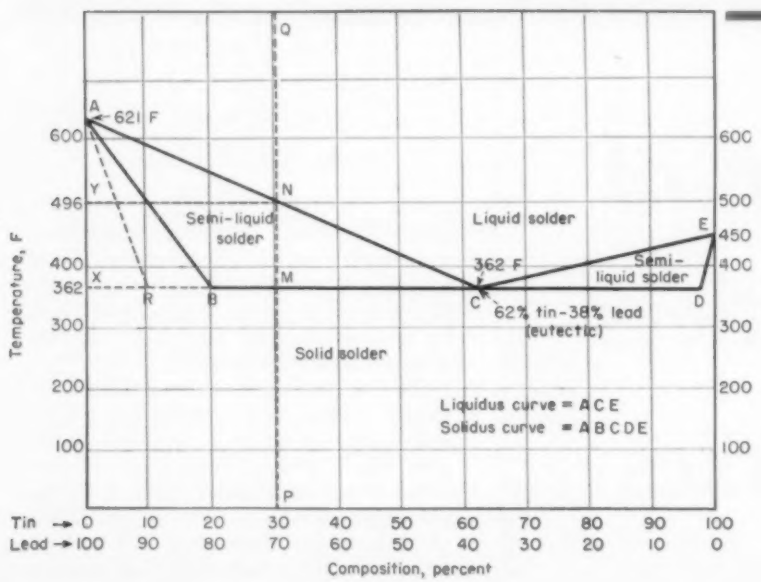

Fig. 1—Constitutional diagram for lead-tin alloys. To illustrate use of this chart, suppose it is desired to know the melting temperatures of a 30 percent tin—70 percent lead solder. Vertical line *PQ* at point represented by this alloy composition intersects the solidus and liquidus at *M* and *N*, respectively. When horizontal lines *MX* and *NY* are drawn from these points, they intersect the temperature scale at 362 F and 496 F, which are, respectively, the solidus and liquidus points. The difference in temperature of 134 F is the melting range for the alloy in question.

Table I—Properties and Uses of Various Soft Solders

Composition by wt, Sn	Pb	Sb	Liquidus Temp, F	Solidus Temp, F	Solidification Range, deg F	Spread Factor*	Spread Area, sq. in. on Cu	Tensile Lap Joint Strength** Cu to Cu, psi	Typical Applications
5	95	....	596	572	24	18	0.23	3,730	Low grade solder; coating, joining, high temperature uses; filler metal: radiators, cans.
15	85	....	553	437	116	23	0.30	5,300	
20	80	....	533	362	171	28	0.37	5,680	
25	75	....	514	362	152	44	0.57	5,700	
30	70	....	496	362	134	64	0.83	5,770	Wiping solder; coils; radiators, cans
35	65	....	478	362	116	85	1.10	6,100	
40	60	....	460	362	98	100	1.30	6,340	General purpose, sheet metal parts, radio and TV, gas meters.
45	55	....	440	362	78	98	1.28	6,420	
50	50	....	418	362	56	95	1.23	6,510	
60	40	....	374	362	12	81	1.05	6,850	Radio, electronics; printed circuits, lithographed cans; high temperature uses; Cu joints in refrigerators, coffee percolators.
62	38	....	362	362	0	77	1.00	6,850	
95	.....	5	467	458	9	...	.....	.....	
..	95	5	554	486	68	...	0.14	3,750	Body solder; coatings metal
3	92	5	536	462	74	...	0.11	5,075	Cans; coatings
15	84	1	527	428	99	...	0.15	5,340	Radiators
29	70	1	475	366	109	...	0.33	6,500	
38	60	2	442	370	72	...	0.25	7,080	Wiping solder.
..**	97.5	....	579	579	0	...	0.19	4,000	High temperature applications, pressure radiators, percolators.
..**	95	....	707	579	128	...	0.20	4,340	
3**	95	....	572	570	2	...	0.18	4,470	
20**	77.25	1.5	503	354	149	...	0.37	6,030	Substitute solders; general purpose.
21**	76.5	1.75	503	358	145	...	0.27	5,950	

* Values related to 40 Sn-60 Pb solder taken as 100. ** Balance silver.
*** Flux used was solution of zinc and ammonium chloride. Joints tested at a constant head speed of 0.2 in. per min at room temperature.

Solder Classifications

The most commonly used tin-lead solders are readily classified according to their composition. Alloys containing up to 5 percent tin are used in applications where high temperature strength is necessary or where a high soldering temperature is not objectionable, and the saving in tin cost is appreciable. Typical examples of the latter are the can manufacturers that use 2.0 Sn—98 Pb solder and the automobile body people who favor the 2.5 Sn—5.5 Sb-Bal Pb composition. After these come the automotive solders for radiators and body repair work. These alloys are generally of the 12 Sn—88 Pb and 20.0 Sn—80 Pb type, respectively.

The range of 25-45 percent tin covers the general-purpose solders with large tonnages of 30-70 being used for sealing automotive radiators. Considerable amounts of 30-70 are also being used in the canning industry where the greater tin content results in a consistently dependable joint. The range of 35-40 percent tin is popular for the wiping solders. The combination of wide plastic range capable of manipulation and shaping with a liquidus temperature sufficiently below the melting point of lead affords a safety margin in making wiped joints in lead pipe. This group also contains the popular 40 Sn—60 Pb solder which has come into very common usage. This alloy's excellent wetting and spreading properties make it popular in the radio and television fields, the sheet metal industry, and for dip tinning of parts to improve solderability and corrosion resistance.

In the next group, the 45 to 62 percent tin alloys, are those particularly desirable for joining applications. Their short pasty range reduces the possibility of the parts moving during soldering. Excellent wetting and bonding properties make the alloys in

this group popular for the fine connections required in radio and electronic equipment. The 60-percent tin solder is frequently preferred for electrical work because of its low melting point.

Once the amount of tin exceeds 60 percent, the high cost of tin discourages use of the tin-lead series. Occasionally 100 percent tin is used in electrical and electronics equipment on which high conductivity at high temperatures is needed.

There are a number of special solder alloys. One is lead containing 2.25 to 2.5 percent silver, the latter being the eutectic composition. It melts at about 580 F, is very fluid when molten, and solidifies completely at a definite temperature. This solder can be used on copper, copper-base alloys, steel and tinplate. Because of good physical properties at elevated temperatures, the solder is used on equipment such as pressure radiators and coffee percolators, which have ambient operating temperatures between 212 and 302 Fahrenheit.

An alloy containing 95 percent tin and 5.0 percent antimony has been used as a soft solder. This exhibits the best physical properties on long-time test at elevated temperature of the alloys which are readily solderable. It melts at only 450 F, yet maintains fair physical properties on long-time test at 325 F. This may be compared to a 40-60 solder with a melting point of 450 F which loses almost all its long-time physical strength at 250 Fahrenheit.

Another special composition contains tin, lead and from 12.5 to 50 percent bismuth. This solder can be used on pewter and other applications requiring a low melting point. It is sometimes used on heat treated surfaces where care must be taken to avoid tempering the metal.

Joints for higher temperatures have been made with a solder containing 95 percent cadmium and 5.0 percent silver. Its solidus is about 640 F and it becomes completely molten at approximately 740 F. A second cadmium-base alloy is one containing 17.5 percent zinc. This eutectic alloy melts at 508 F and is recommended for soldering zinc-base die castings.

While it is generally recommended that aluminum and its alloys be welded rather than soldered, some solders have been developed for aluminum. These contain 30 to 75 percent tin; the balance is usually zinc. The alloys containing the higher percentage of zinc are found to be slightly better from a corrosion standpoint, but the temperature of application becomes much higher. For that reason, the solders found to give the best compromise have been in region of 60 tin—40 zinc.

Table I includes a wide selection of common and special solders, along with their individual characteristics and major applications in industry.

General Considerations

Strength. Soldered joints are acknowledged to be comparatively weak and unsuitable for heavy loads, continuous stress and/or high temperatures. Mechanical or other means of support are therefore utilized to insure satisfactory performance. Table II shows the effects at room temperatures of aging and sustained loading on the strength of soft soldered units.

Solder's ability to resist breaking is measured in terms of tensile, shear, and impact strength. When tin and lead are alloyed, the resultant tensile strength is greater than that of either metal alone. It increases rapidly up to 15 percent tin and more gradually thereafter. A maximum strength of about 6,500-6,800 psi occurs at the eutectic point. These values are usually 15 to 50 percent higher than the shear strength, while impact strength ranges from 12 ft-lb for the low-tin solders to about 15 ft-lb for the eutectic alloy. As temperature increases to 362 F when most lead-tin solders begin to melt, their tensile strength decreases. The loss in strength on short time, when brass plates $\frac{3}{4}$ in. wide are soldered with a 40-60 Sn-Pb alloy to form 0.250 sq-in. joints is from 6,340 psi at room temperature to about 1,900 psi at 300 Fahrenheit.

Spread Characteristics. Ease of manipulation of a given solder is another critical factor. This quality depends on the spreading characteristics which are highest in alloys containing 40 to 50 percent tin. Table I compares spread factors of several solders with that of the 40 tin—60 lead composition which is taken as 100.

A low spread factor should not necessarily be cause for rejection of a given solder, for it may have other characteristic so important that this limitation will be minimized. Sometimes a higher tin content will prove best, even though more costly. This is because a high spread factor means faster soldering.

Soldering Method. Equipment used in a particular soldering operation will depend mainly on the parts to be joined, and requirements of a given production set-up. Apparatus for hand soldering includes soldering bits, electric soldering guns, gas burners and blow torches. Automatic furnaces and induction heaters, in which the parts are placed already tinned and assembled, are used for high-production items. Table III lists the commonly-used soldering techniques.

Joint Design. Parts should be designed to meet the requirements of a chosen soldering method. Surfaces should be shaped so that they engage or interlock and leave to the solder the functions of sealing and solidifying the assembly.

Spot welding or tacking the surfaces before soldering to relieve stress is part of the design picture. Soldering at corners or edges where the stress is greatest should be avoided. In some cases, lids and ends of containers can be formed by stamping or pressing so that the soldered seam is on the side. As shown in Fig. 2, lock seams are stronger than lap seams.

Joints should not be too close to insulation that might be damaged by

Table II—Effect of Sustained Loading and Aging at Room Temperature on Strength of Brass Lap Joint (40 Sn—60 Pb Solder)

Loading Period or Aging Time, hr	Tensile Strength After Aging, psi	Breaking Load, psi
0	6,340	6,340
1	6,250	1,600
10	5,800	1,120
40	5,450	.....
100 (4.16 da)	5,250	800
1,000 (1.37 mo)	4,850	560
10,000 (1.14 yr)	.....	400*

* Extrapolated

Table III—Commonly-Used Soldering Techniques

Copper-Bit—Usually hand operated, although bit (iron) can be supported in automatic setup; shape and size of bit are dictated by nature of joint. This method is used for small joints where rapid soldering is not required.

Torch or Flame—Rapid heating with single or multi-flame tips, either manual or automatic; technique is useful in heating large parts or for concentrating on one part of a complex assembly.

Hot Plate or Oven—Adaptable to high speed production where parts are assembled with solder preforms located at respective joints. Fluxing is essential; non-oxidizing atmosphere is sometimes utilized.

Induction—Eddy current heating from high-frequency coil affords close temperature control without risk of local overheating. Joints must facilitate coil setup.

Dip—Immersion in solder bath lends itself to high-production methods; usually applied to thin sheet metal where clearances are small and large fillets not required.

Electrode—Part is connected to one terminal of low-voltage supply and soldering bit to other. Contact between bit and work closes circuit to generate heat.

Resistance—Similar to electrode soldering except that parts are clamped between two electrodes. Resistance at joint produces heat for melting preplaced solder.

Spray—Special gun atomizes solder and applies it to prefluxed surface. Usage is limited to dented or cracked components.

Supersonic—Relatively new technique designed to erode aluminum oxide films by high frequency cavitation; applicable to small parts, primarily aluminum.

heat. Neither should they be placed so close together that there is risk of melting or weakening joints made earlier.

Clearance is also important in joint design. Parts should fit closely so that the space between them is narrow enough to become completely filled with molten solder drawn in by capillary action as the solder wets the metal. On the other hand, when there is not enough clearance, solder cannot penetrate and dry joints may result. In general, a clearance of from 0.003 to 0.005 in. is satisfactory with surfaces that have not been coated with tin or solder before being assembled. For round or tubular members, this means a clearance on the radius. When tinned metals are joined, a clearance of 0.001 in. is sufficient.

In establishing clearance, allowance must be made for thermal expansion and contraction, particularly if the metals are dissimilar. A good rule is to allow for a rise in temperature of about 500 F. For long soldered seams, it is advisable to specify tacking the surfaces in the middle and at each end, and at short intervals in between. This method insures more uniform temperature conditions and reduces buckling.

Surface Requirements. The temperature of the metal surface at the point of soldering should be at least equal to or slightly higher than the liquidus temperature of the solder being used. Likewise, it is essential that the tin-lead solder wet the surface of the solid metal. An intermetallic compound forms between the copper, steel or brass, and the solder. The strength of these compounds is far in excess of the strength of solder and, therefore, the joint will withstand much greater stresses than the solder itself.

Fillets. The use of fillets is often misunderstood, particularly in the interpretation of a satisfactory joint. The presence of a sizeable fillet does not always indicate a completed joint and in many cases may show the opposite. The fact that the solder builds up at the fillet may demonstrate that the joint has not been fluxed or has not reached a sufficient temperature to permit the solder to flow. A large fillet probably means that the metal has been heated into the plastic range and puttied into the joint. The presence of solder as a fillet should be an indication that sufficient metal was present in the joint to satisfy the capillary action. The strength of the joint depends almost entirely on the effectiveness of the bond that exists between the joined surfaces.

Size of Solder Bar. When preparing specifications for soldering materials, some thought should also be given to the form and shape of the solder to be used. The industry has developed many standard sizes and shapes to fit specific applications, and advantage should be taken of these forms. Wherever possible, special sizes and shapes should be avoided because they are usually more expensive. With equipments that incorporate a melting device, it is preferable to use large size pigs rather than the more costly small ingots or bars. In some hand soldering operations, it is more economical to use wire or core-filled solder than bar solder, which is difficult to handle.

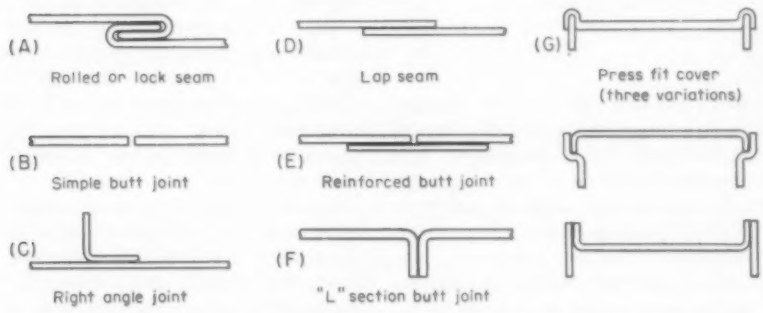

Fig. 2—Joint configurations range from the commonly-used rolled seam and press fit cover to the low-strength simple butt joint. Riveting or spot welding is often used in *C, D, E* and *F* joints to position parts and add strength. When thicknesses of parts being joined differ, thicker piece is heated first and thinner one heated by conduction.

Table IV—Flux Chart

Base Metal or Applied Coating	Plain Rosin	Activated Rosin	Zinc-Ammonium Chloride
Hot tin dipped	Yes	Yes	Yes
Hot solder dipped	Yes	Yes	Yes
Electrotin	Note 1	Yes	Yes
Silver plate	Note 2	Note 2	Yes
Cadmium plate	Note 3	Note 3	Yes
Nickel plate	No	Fair	Yes
Galvanized steel	No	No	Note 4
Copper	Note 5	Yes	Yes
Brass	Note 5	Yes	Yes
Phosphor bronze	Note 5	Yes	Yes
Beryllium copper	No	Note 6	Yes
Aluminum bronze	No	No	Note 7
Silicon bronze	No	No	Yes
Zinc & zinc plate	No	Note 4	Note 4
Monel	No	Fair	Yes
Nichrome	No	No	Note 8
Steel	No	No	Yes
Stainless	No	No	Note 8

Note 1: Solderability of electrotin plated surfaces varies considerably with thickness of plate, length of storage period, and residues left from plating operation. When surface conditions are poor, plain rosin flux will not produce a consistent joint. If plated surface is dipped in hot palm oil and melted, its solderability is greatly improved and susceptibility to change during storage reduced.

Note 2: Silver plated surfaces as well as solid silver are readily solderable with plain rosin when clean, but when corroded or tarnished resist the action of flux. In more severe cases, surface will resist action of the activated rosin fluxes and respond to an acid flux, unless some mechanical cleaning is done. Best practice is to reduce the elapsed time between preparing the surface to be soldered and making the joint.

Note 3: Success of soldering to cadmium plated surface is largely dependent upon thickness of the plate. With sufficient plate, plain rosin will produce satisfactory joint, but with thin plates, 0.0002 in. and less on steel surfaces, trouble may be encountered even with activated rosin fluxes. Thin cadmium plates dissolve in the solder, producing a condition wherein a rosin base flux is attempting to wet a steel surface. This difficulty is magnified if there is any time delay in forming the joint which would allow the cadmium to go into solution. When the plate is used over aluminum, the above difficulties are more pronounced, as none of the standard fluxes will make the joint except at high temperature.

Note 4: A galvanized surface can be soldered with the zinc-ammonium chloride flux, but better results are obtained if some free muriatic acid is added. This is true for galvanized, zinc plated and zinc surfaces.

Note 5: Copper, brass and some bronzes can be soldered with plain rosin as the flux, provided they are cleaned carefully before soldering. On tarnished surfaces, it is best to use an activated rosin if corrosion is a factor, or to choose a dilute zinc-ammonium flux if a thorough washing is the final step.

Note 6: When properly cleaned, as noted in text, beryllium copper can be fluxed with plain rosin, but when the surface is in poor shape, it will require a strong acid flux.

Note 7: A zinc-ammonium chloride flux is satisfactory for aluminum bronze; superior results will be obtained if an 85 percent orthophosphoric acid flux is used.

Note 8: Alloys of iron, nickel and chromium, or nickel and chromium will solder successfully if stainless steel fluxes are used. In general, these fluxes contain free muriatic acid in addition to the zinc-ammonium chloride salts. This acid may represent from 25-50 percent of the liquid phase of the flux and result in a highly corrosive material which must be removed from the joint after soldering.

Soldering Fluxes

Since the melting range of solder varies with its composition, every soldering flux cannot be used with every tin-lead solder. Their melting range is from 362 F for the eutectic alloy to 621 F for pure lead. Fluxes for the near-eutectic alloys must therefore have a melting point less than 362 F. And unless the flux particles are completely liquid at the soldering temperature, solid inclusions may remain in the joint, resulting in unsound joints and in-service corrosion.

Though there are many different fluxes available, they can be classified in two general groups: (1) corrosive or acid and (2) non-corrosive. This classification refers to the residue left after the fluxing action is completed. Table IV lists pertinent data for various fluxes.

Zinc chloride, the most common corrosive flux, is used extensively in the easy-to-use "acid core solders". Having a melting point above 500 F, this flux should not be used alone with solders containing more than 30 percent tin because the latter melt at temperatures less than 500 Fahrenheit.

An ammonium chloride solution alone is not as effective as the zinc chloride because it is changed to a gas on heating, and ceases to be a protective coating. However, when ammonium chloride is added to zinc chloride, the ammonia and hydrochloric acid gases supplement the fluxing and protective action of the zinc chloride by increasing the overall oxide-penetrating characteristics.

Zinc and ammonium chloride are therefore the basis of most acid fluxes. The ammonium chloride usually represents 5-10 percent of the combined weight of the chlorides, which are dissolved in water and used when soldered parts can be washed after joining. Copper, steel, brass, galvanized and terne-coated surfaces respond well to this type flux.

Dilute hydrochloric acid, alone or mixed with equal portions of the zinc-ammonium chloride flux, is widely used on stainless steel and other metals which have tightly adhering oxides. A still stronger flux, effective on metals with highly resistant oxides, can be made by adding hydrofluoric acid to the same base.

Another good flux for use on steel, copper and brass is orthophosphoric acid in 40 percent solution by volume. And whenever lead-silver solders are used, zinc chloride fluxes containing small amounts of stannous chloride are satisfactory.

The principal non-corrosive flux is rosin, which is sufficiently reactive to metals at soldering temperatures to be useful in a variety of applications. The advantages of rosin are that its residue is non-corrosive, non-conductive and non-hygroscopic. It reacts only mildly with metallic oxides and requires that parts be thoroughly cleaned and/or tinned. A typical application is on low-current electrical connections where functioning of the equipment would be seriously impaired by a small change in circuit resistance caused by corrosion.

In cases where rosin is not sufficiently active, the so called activated rosin fluxes are used. The increased chemical activity is obtained by adding small amounts of organic acids or compounds to the rosin.

A new group of fluxes has been introduced during the last couple of years for use, in particular, on copper and copper alloys. These are the

hydro-zinc-base fluxes which are popular because of the sharp reduction in the amount of corrosion developing after completion of a joint. This feature is attractive on operations where cleaning the joint after soldering is difficult and expensive.

The self-neutralizing type fluxes are also worthy of note. This is somewhat of a misnomer since the so-called "neutralizing" action of the flux occurs when the components have been exposed to the soldering temperature. These fluxes depend upon elimination of corrosive components through evolution or chemical combination. Neutralizing action is lost if all chemicals are not at soldering temperature.

Solderability of Base Metals

Ferrous Materials. Low-carbon steels can be soldered successfully with any type of tin-lead solder and by any of the recognized processes. As long as the steel is clean and an acid type flux is used, no difficulties should arise. Precoating with tin or solder facilitates soldering with non-corrosive fluxes.

Stainless steels are more difficult to solder because of their low thermal conductivity and tightly adhering oxide film. Stronger fluxes such as zinc chloride fortified with muriatic acid are necessary. Stainless steels containing molybdenum, titanium or columbium may require a flux containing a few percent hydrofluoric acid in addition to the zinc chloride and muriatic acid. Tin-lead solders and sometimes silver-tin solders are also used.

A machined cast iron surface is difficult to solder because of the free graphite present. A method such as shot blasting, followed by degreasing is found to improve the solderability, although an electrolytic cleaning in a salt bath gives best results. If the surface is then pretinned by hot dipping or electrolysis, a mild flux can be used.

Copper and Its Alloys. Any type of tin-lead solder is applicable, but even with a 40-50 percent tin, it is not good practice to use a plain rosin flux unless a careful cleaning procedure has been followed. Activated rosin fluxes are generally capable of preparing a copper surface for soldering without the necessity of cleaning. On copper surfaces, a dilute zinc ammonium chloride flux or equivalent is used.

Though copper is readily solderable, its alloys vary in degree of difficulty to a point of near impossibility. Considering these alloys in order of solderability, there are the tin bronzes, red brasses, yellow brasses, beryllium copper, silicon bronzes, aluminum and manganese bronzes.

The first three of these allows present little trouble. Dilute chloride fluxes or equivalents are satisfactory and can be used with almost any tin-lead composition. If a less corrosive flux is necessary, as mentioned before, the activated rosin fluxes can be used with a 40-50 percent tin solder.

Beryllium-copper is an alloy that forms a resistant oxide coating during heat treatment. If the metal has to be soldered at this point with a non-corrosive flux as is the case with many springs, diaphragms and gages, thorough cleaning is mandatory.

The silicon and aluminum bronzes will solder with 85 percent phosphoric acid, provided the surfaces are cleaned by machining or abrasion. With the manganese bronzes, however, the problem of obtaining a satisfactory joint is somewhat different. If parts are not heated, fluxed, soldered and cooled rapidly, a poor joint will result.

Nickel base alloys such as Monel, Inconel, Nichrome and nickel plated surfaces cannot be soldered with plain rosin, although Monel and nickel plate can be soldered reasonably well with an activated rosin flux. With the other alloys, it is necessary to use zinc-ammonium chloride with a large percentage of free muriatic acid to obtain a satisfactory joint. A 40-50 percent tin solder is advisable.

Aluminum. The size of the parts being joined is the critical factor. Small aluminum parts can be brought up to soldering temperature, 550-700 F, and held there. On large parts, sections adjoining the soldered area will conduct heat away so fast that it is not possible to hold the working area at the correct temperature long enough to complete the joint.

A relatively new method of soldering aluminum parts is the ultrasonic vibration of the solder in contact with the aluminum to erode the oxide coating. Only small pieces or local areas of large parts have been successfully soldered. It should be understood that this method of soldering does not overcome the fundamental difficulty of a soldered aluminum joint; the galvanic attack that occurs when metals widely separated on the electromotive series are brought together.

Most alloys for soldering aluminum contain 60-90 percent tin, with the balance zinc. For many years, a 60 Sn-40 Zn solder has been recommended, but the 90 Sn-10 Zn alloy has superior corrosion resistance when the joints are exposed to moisture.

The commercial and high-purity aluminum grades of aluminum solder satisfactorily with proprietary fluxes of the hydrofluoboric type or equivalents. The alloys of aluminum may vary widely in solderability, with alloys containing more than one percent manganese rejecting the solder after tinning.

Electroplated Coatings. Tin and tin-lead plated parts are easy to solder with non-corrosive fluxes. The soldering characteristics of cadmium on copper or brass are not quite as good as those of tin, using a resin-type flux. On steel, a coating thickness of not less than 0.0003 in. is specified.

Silver plating can readily be soldered (except as noted in Table III) to achieve the usual qualities of tin-lead solders using non-corrosive rosin fluxes. Since thin silver coatings dissolve in solder, they should not be less than 0.003 in., preferably 0.0005 in.

The soldering of plated zinc coatings varies appreciably with the time elapsed after plating. For a period of less than one day, soldering with mild fluxes is a possibility, but after a few days it is best to use a chloride flux containing a small percentage of muriatic acid. On galvanized surfaces, the latter flux should always be used.

The tin-alloy electroplates recently developed as corrosion resistant coatings for iron and steel are readily solderable with rosin or reactive fluxes.

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Integrators for Computers

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PERHAPS THE MOST COMMON application of the integrator is the household electricity meter where it is used to integrate the product of current and voltage with respect to time to give the energy consumed by the household appliances. Conversely, the most complicated application is to the solution of differential equations. In control mechanisms, integrators of some form or another are used to provide derivatives and integrals for optimizing the steady state and transient response of such systems.

The Amsler planimeter, the Kelvin Wheel, and Coradi integraph are all examples of some of the earlier mechanical devices used for integration. As mechanical integrating devices require infinitely variable speed gearing, and since all these early models depend on some form of friction drive, they are not suitable for applications in which appreciable torque is required at the output shaft. With the development of the mechanical torque amplifier, however, use of the Kelvin Wheel was extended to computing problems.

Devices used for carrying out mathematical operations fall into two broad classes: analog and digital. In analog devices the inputs to, and outputs from the device are represented by physical quantities such as displacement or rotation of a shaft, voltage, current, intensity of light, and so on. In digital devices the inputs and outputs are represented in some form of number code. Analog mechanisms are essentially continuous in the mathematical sense, and digital elements operate in discrete steps. It is something of a paradox that analog integrators, which operate continuously and which do in fact bridge the gap between the limit

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Analog Integrators

Analog integrators may be subdivided into the following classes:

(a) Mechanical
(b) Electro dynamical
(c) Electrical
(d) Hydraulic and pneumatic

With the exception of the mechanical integrator, all of the other types integrate with respect to "real" time. This limits the flexibility of their use; but in spite of this, they have properties which find use in special applications.

Mechanical Integrator. Although somewhat old-fashioned, the mechanical integrator (1) has the unique property of being able to carry out integration with respect to an arbitrary argument or independent variable. This means that apart from integration it may be readily employed for performing a variety of other mathematical operations—multiplication, division, and function generation (1, 7).

The principle of opertaion is shown in Fig. 1. Mechanically the device is nothing more than an infinitely variable gear unit. The cage containing two balls is forced to move, by suitable guides and lead screws, across the face of a ground and hardened disk. A cylinder, also ground and hardened, is mounted so that its axis is parallel to the line of travel of the balls, and in addition is perpendicular to the axis of rotation of the disk. The component parts are held in contact by means of suitably arranged springs. If a rotation dx is given to the disk when point of contact of the balls is a distance y from its center, then the rotation dz transmitted to the cylinder, assuming no slip takes place between components, is:

$$dz = \frac{1}{C}\, y\, dx$$

where C is a constant which depends on certain dimensions of the apparatus. If continuous motions are transmitted to the disk and the ball cage drive, then the accumulated angular displacement of the cylinder is:

$$z = \frac{1}{C} \int y\, dx$$

For well made components, an accuracy of approximately one in a thousand is readily obtainable with an integrator of this type, Fig. 2. However, it is necessary that the output shaft be lightly loaded so that slipping between components will not occur. This usually means that the output must feed the input to a torque amplifier or servo-mechanism if any appreciable power is to be taken from the unit.

An accuracy of one part in ten thousand could be obtained with this type of integrator. The cost of achieving this would, however, be very great. Such accuracy would only be required in complex computing applications. The advent of digital integrating tech-

and Control Systems

of a summation of small steps and the definition of an integral, are limited in accuracy (an accuracy of 1 in 1,000 is common) because of the finite limit of accuracy to which mechanical and electrical apparatus can be constructed. Digital devices, on the other hand can be crude in construction, and by using some approximate integrating formula, such as Simpson's rule, can achieve any arbitrary order of accuracy (1 in 1,000,000,000 or higher) simply by using a sufficient number of digits in representing the variables.

The permissible crudity of construction of a digital device stems from the fact that each individual element need only have an accuracy that corresponds to the radix, or base number, of the digit code used. Thus, if decimal representation is being used and a mechanical system is to be made, then a ten-toothed wheel that will lock in any one of ten positions is all that is required for representing one digit stage. If, as is common, a binary system of number representation is used, then the device required to do this need only distinguish two states. This has led to the development of electrical and electronic techniques, whereby the digits 0 or 1 of a binary number may be simulated by a relay being either open or closed, an electronically generated pulse being present or not present, or various other equally simple devices. Although the principles of digital computing devices have been used in desk machines and punched card equipment for many years, it is only the recent development of high-speed electronic digital devices (carrying out 10,000 or more basic steps a second) that has made the digital integrator a rival of the analog integrator.

In spite of these recent developments the digital integrator has by no means superseded the analog device in all applications. In fact, there are so many uses now for integrating mechanisms when the field of control systems is included, that all types at present developed have special fields of usefulness.

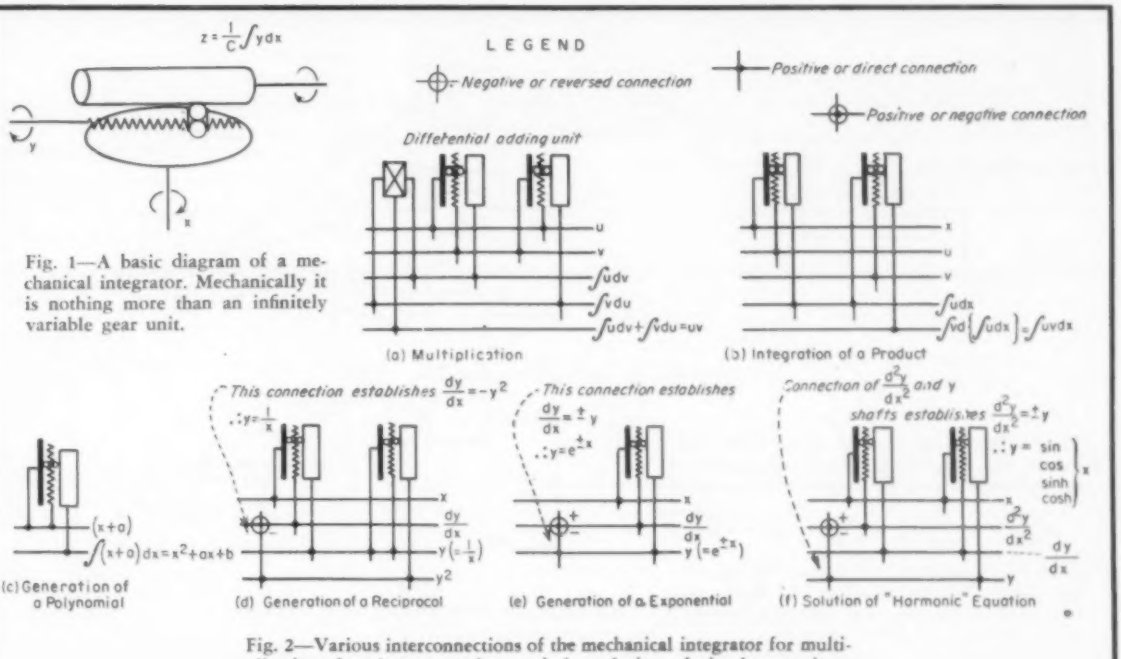


Fig. 1—A basic diagram of a mechanical integrator. Mechanically it is nothing more than an infinitely variable gear unit.

Fig. 2—Various interconnections of the mechanical integrator for multiplication, function generation, and the solution of simple equations.

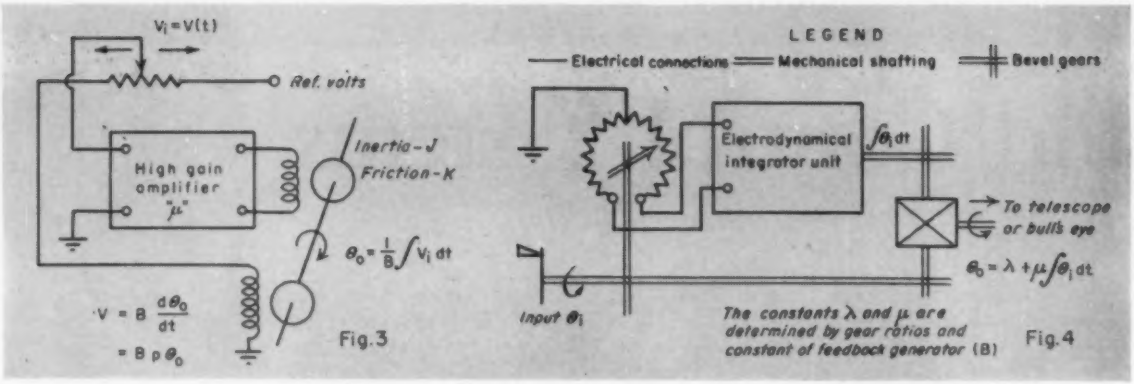


Fig. 3—Diagram of an electrodynamical integrator, illustrating the basic and well-known principle of a closed loop speed-controller. This type integrator will deliver considerable torque.

Fig. 4—Diagram of an electrodynamical integrator. It is well suited for use with aided tracking mechanisms and will operate at speeds up to ten times those of the mechanical device.

niques has done away with the need to advance the accuracy of analog integrators beyond economical limits.

Electrodynamical Integrator. The electrodynamical integrator, Fig. 3, depends on the principle of accurate and linear speed control of an electric motor. The speed of the output shaft is directly proportional to the voltage applied to the control windings of the motor. Any d-c motor where speed is proportional to the field current or voltage is thus an integrator of sorts. However, to achieve accuracy and consistency, some kind of speed control servomechanism is required.

For accurate operation, it is necessary that the tacho-generator or feedback element have a linear voltage-speed characteristic, and that the reference voltage and input resistance be stable. As these are low energy or passive elements, they can be made to precision limits without great cost. The amplifier and the motor need not be precision built, for the performance of such a system is independent of the forward loop elements, provided that their overall gain is high. If a voltage, V_i is applied by suitably tapping the input resistor, then the speed of the output shaft is proportional to this input quantity. The accumulated angular rotation of the output will then evaluate the integral of V_i with respect to time. The behavior of such a system is represented more completely by the operational equation:

$$\theta_o = \frac{1}{\frac{Jp + K + B}{\mu}} \cdot \frac{V_i}{p}$$

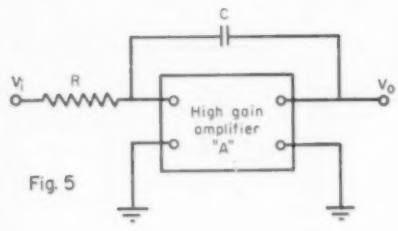
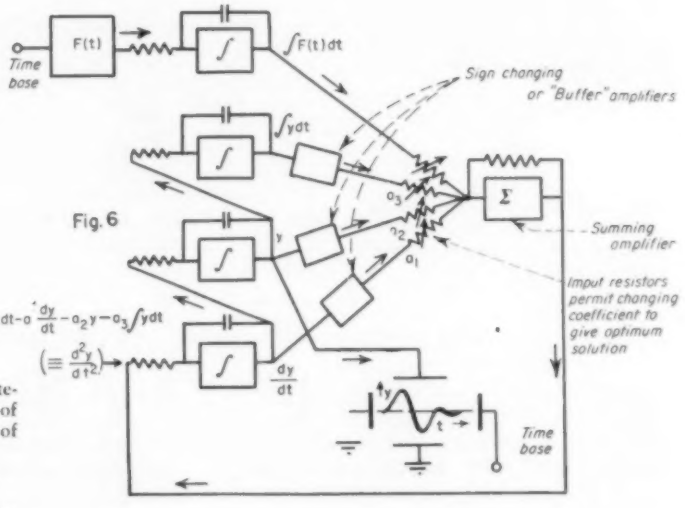


Fig. 5—The circuit diagram of the Miller integrator, and, Fig. 6, the typical arrangement of several integrators of this type for the solution of

$$\frac{d^3y}{dt^3} + a_1\frac{d^2y}{dt^2} + a_2\frac{dy}{dt} + a_3y = F(t).$$

Electronic integrators are most useful for solving servomechanism, trajectory and flight problems, and other dynamical problems involving real time.



Equation may be written after one formal integration

$$\frac{d^2y}{dt^2} = \int F(t)dt - a_1\frac{dy}{dt} - a_2y - a_3\int y dt$$

As indicated above, integrators of this type integrate with respect to real time, and it is therefore appropriate to use the differential operator p ($\equiv d/dt$) in writing down this equation. It will be seen that as the gain of the amplifier is increased, the relation between input and output approaches the characteristic of an ideal integrator, for example:

$$\theta_o = \frac{1}{Bp} V_i \quad \text{or} \quad \frac{1}{B} \int V_i \, dt$$

By comparison with the mechanical integrator, this type, though limited to real time integration, may be constructed at considerably less cost. Fig. 4 illustrates one application. The electrodynamical integrator will also deliver considerable torque. Furthermore, this particular type of integrator can cope satisfactorily with inputs that vary very slowly with time, and as a result are useful for applications where it would be difficult to use the other types of electrical integrators to be described.

Electrical Integrators. Electrical integrators are finding wide application because of their low cost and extremely high speed of operation. They vary from simple networks that operate on approximate integration laws to networks using feedback from high gain amplifiers. This latter results in accuracies better than 1 percent being possible. Fig. 5 shows a commonly used integrator circuit which employs negative feedback. It is commonly known as the Miller Integrating circuit, and was originally devised for producing triangular wave forms for Cathode Ray Tube time bases.

If the input voltage V_i is a time varying quantity, then the output voltage is given by:—

$$V_o = \frac{1}{\frac{1 + pCR}{A} + pCR} V_i$$

When the amplification factor is large, this becomes:—

$$V_o = \frac{1}{RC} \int V_i \, dt$$

This type of integrator is used extensively in electronic differential analyzers and simulators, Fig. 6, with some of the larger simulators having as many as 500 such integrators.

In control system applications, approximate integrators are constructed from passive circuit elements such as resistors and capacitors. Typical of such devices for d-c operations is the network shown in Fig. 7 a and 7 b.

Here:—

$$V_o = \frac{1 + pCR_2}{1 + pC(R_1 + R_2)} V_i$$

The output is comprised of a direct component of input as well as a component of its integral with respect to time. Furthermore, the ratio between the two components is dependent of time, and the design of such circuits therefore becomes one of selecting suitable values for the resistances and capacity of the elements in order to achieve an optimum performance for a given range of p.

Passive networks for producing an "integrator" characteristic for a-c signals fall more naturally into the field of filter design and give rise to various types of band-pass filter.

Hydraulic Integrator. The fourth class of integrators depends on certain well known properties of hydraulic and pneumatic mechanisms (6). Hydraulic integrators are little used in computing applications. In the control system field their use is quite extensive, especially in those mechanisms which use hydraulic and pneumatic elements for the main power units. In addition, hydraulic integrators are used in purely mechanical systems—for example in

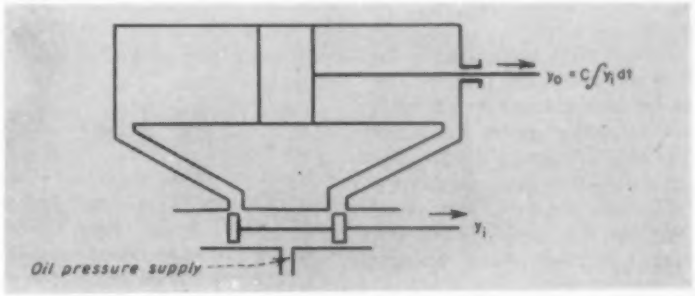
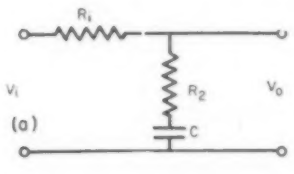


Fig. 8—Diagram of a hydraulic integrator. A special advantage for control system applications, where their use is extensive, is the facility with which very long time constants (hours or days) may be incorporated in their design.



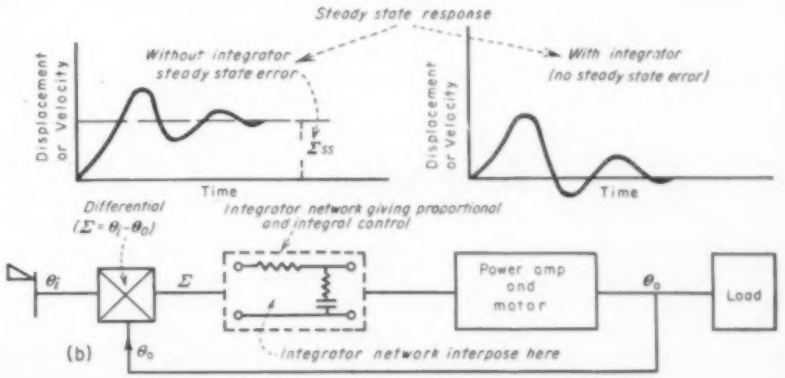


Fig. 7—(a) Diagram of a passive integrating network, and (b), a cascade integrator network in simple servo to improve steady state performance.

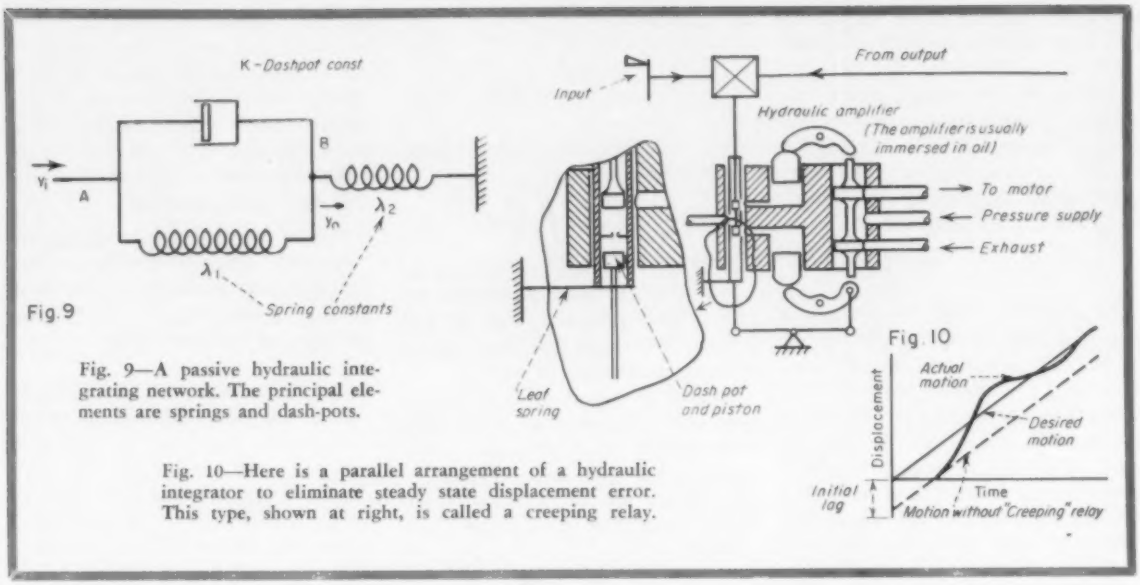


Fig. 9—A passive hydraulic integrating network. The principal elements are springs and dash-pots.

Fig. 10—Here is a parallel arrangement of a hydraulic integrator to eliminate steady state displacement error. This type, shown at right, is called a creeping relay.

the acceleration dash-pot of certain types of carburetors.

In principle, hydraulic integration is an extremely simple matter. Fig. 8 shows diagrammatically the essential nature of such a device.

A sensitive valve is displaced by the input y_i and allows the pressure supply to be communicated to the main cylinder, and thus moves the piston an amount y_o. Assuming that the supply pressure is constant and that the flow is laminar, the rate of flow of oil passing into the main cylinder will be in strict proportion to the opening of the sensitive valve, i.e. $y_i \propto dQ/dt$; where Q is the total flow.

If the cross section of the main cylinder is uniform, then:—

$$y_i = C \frac{dy_o}{dt}$$

or

$$y_o = \frac{1}{C} \int y_i \, dt$$

where C is a constant which takes account of supply pressure, oil viscosity, and the geometrical dimensions of the system.

This is clearly analogous to the ideal pneumatic integrator, which is a device whose internal pressure is proportional to the time integral of the volumetric flow into it.

$$p = \frac{1}{C} \int q \, dt$$

here p is the pressure, q the flow, and C is in effect a "pneumatic capacitance" One of the most common forms of pneumatic integrators is a tank or vessel, closed except for one feed tube.

As mentioned earlier, hydraulic and pneumatic integrators are not much used in computing applications, for their absolute accuracy is not high. In this respect, change in viscosity of the working medium, whether air or oil, is a principal contributory factor.

Passive hydraulic and pneumatic integrating devices have many uses. As in the case of electronic passive element integrators, they are usually approximate in operation and combine an integrating function with a direct acting component. An example of a hydraulic passive integrating network is shown in Fig. 9.

The principal elements are springs and dash-pots. In this case the integral is measured by the differential movement between A and B, that is, the relative movement of the dash-pot piston and cylinder. The differential operator expressing the relation between input (y_i) and the integral is:

$$\frac{\lambda_2}{(\lambda_1 + \lambda_2) + Kp} y_i$$

where K and the λ's represent the physical constants of the dash-pot and springs respectively. Such a device as this is well suited for parallel integral compensation in hydraulic amplifiers, as indicated in Fig. 10. The same application is shown electrically in Fig. 7(b).

Digital Integrators

It is perhaps somewhat inaccurate to refer at all to a digital integrator, for digital integration is a procedure rather than the byproduct of a physical mechanism. Equipment is required, of course. However, it is equipment for performing basic logical (arithmetical) operations rather than for establishing a particular physical analog. In fact, digital integration is carried out by a basic digital adding mechanism, a counter or accumulator. Mechanical, electro-mechanical (relays) and electronic devices exist, but the principle of their use is the same, and the main difference resulting from the use of one or the other is speed. This is important however, as integration is basically a continuous process and if performed by a step-by-step or digital methods, a very large number of

small increments must be used. It is only the advent of high speed electronic devices that have permitted digital techniques to rival analog methods in complex calculations and continuous control problems.

The recent advances in digital computation have resulted in a novel approach being made to the problem of carrying out of arithmetical processes. Up to this time the decimal system of representing numbers has been universally employed—both in hand calculations and in desk calculating machines. However, the use of numbers in decimal form requires that the physical apparatus with which each digit position is represented should have ten distinct stable states or positions. While this presents no difficulty with a mechanism of the type used in standard desk calculating machines, it does, on the other hand, demand very complex equipment when translated onto the electronic plane. For complete high speed calculating machines where a thousand ten digit numbers or more need to be stored and manipulated, the amount of equipment required is prohibitive.

As a result, a recourse has been made to the system of representing numbers in binary form. Instead of using 10 as the radix, 2 is used. This permits the digits of a number to be simulated: by the presence or absence of a pulse; by one or other of the two stable states of a multi-vibrator; by positive or negative pulse patterns on a magnetic drum or wire; and by various other simple and economical devices.

In addition to the far reaching effects the method of representing a number has on the design and cost of the equipment to be used, the basis of design is also affected by whether the arithemetical operations are carried out "serially" or "in-parallel". In a serial machine corresponding pairs of digits of numbers are added in succession. In a parallel machine all digits are operated on simultaneously. The ratio of equipment required in a parallel device for performing additions to that required for serial system is roughly equal to the length (in digits) of the number. The speed at which the two devices will operate is in the inverse ratio of this number. For example, if an adding unit is to be designed to handle ten digit numbers, then a parallel device would require about ten times as much equipment (valves, relays etc.) as a serial adder. It would, however, operate ten times as fast.

The possibilities listed above therefore, give rise to four types of digital computing units:

(a) serial-binary
(b) parallel-binary
(c) serial-decimal
(d) parallel-decimal

The serial-binary is the cheapest and slowest, and the parallel-decimal the fastest and most expensive.

When considering the design of a large computing machine with its multiplicity of units, the choice of serial-binary working is in most cases readily dictated on the score of cost. However, when considering a special purpose device such as a single adding unit for integration, the choice can rest on more technical foundations; and depending on the use to which it is to be put, any one of the four possibilities may prove to be best in the particular circumstances.

In its simplest form a digital integrator is simply an accumulating counter. However, if the integrator is to integrate some physical variant—a shaft rotation or a voltage—then some form of quantizer is required. The successive quanta are fed into the counting unit, and the accumulated total, multiplied by a scale factor (dependent on the quantizing interval), is the integral, Fig. 11.

If the integral is not a continuously varying physical quantity, but instead a table of data stored on teletape, punched cards, magnetic wire or drum, the process is much more simple as the no quantizing and analog-to-digital conversion are required. Instead, the stored values of the integrand are added directly into the accumulator.

Overall accuracy depends on the accuracy of quantizing, and on the interval between samples. The smaller the interval, the more accurate the integral. If reduction of the interval adds too much time to calculation, or alternatively, if stored data is not given at sufficiently close intervals, then instead of a simple addition it may be necessary to use some suitable quadrature formula such as Simpson's Rule or the Gauss Integration Formula.

Although a variety of auxiliary equipment may be necessary in constructing a digital integrating system, the essential functional element so far as the integration process is concerned is the adding device. There is now a

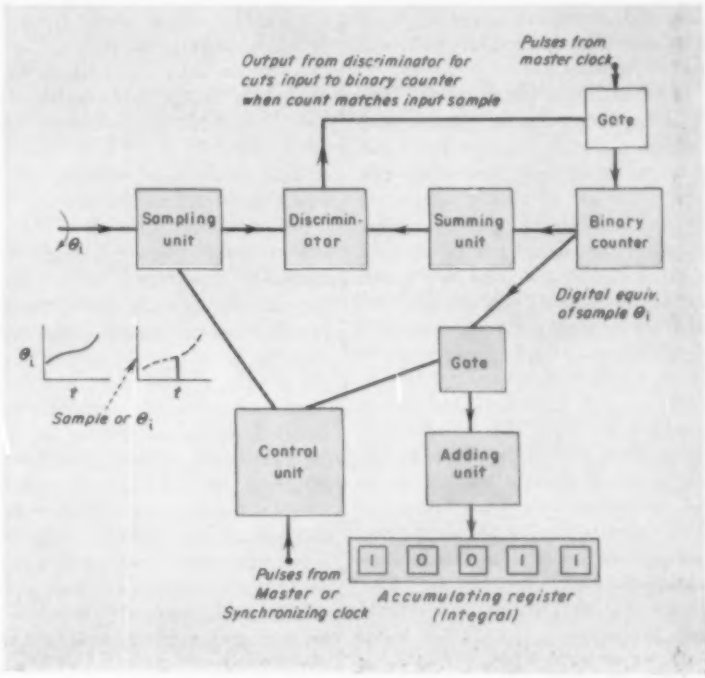


Fig. 11—A line diagram showing the relationship, one to another, of the principal units of a serial binary digital integrator.

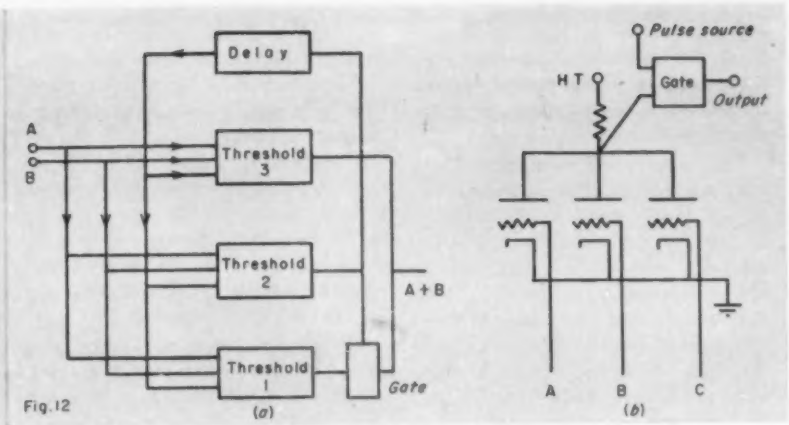


Fig. 12—The basic mode of operation of a serial-binary adder. Consisting of three devices of thresholds, they provide an output when three or more, two or more, and one or more signals are applied at the input.

wide variety of adding devices, like the serial-binary adder, Fig. 12(a). It consists essentially of three devices of thresholds "three", "two" and "one". By this is meant that the devices provide an output when three or more, two or more, and one or more signals are applied at the input. An electronic device for achieving this is an adding gate, shown in Fig. 12(b). When the three tubes are conducting the voltage at the common plate, resistance is low enough to effectively close the output gate. By appropriately choosing the gate cut-off voltage, the appearance of one, two, or three negative pulses at inputs A, B, and C will open the gate. In addition to these three units, a delay line, giving one pulse period delay, is used to delay the "carry" digit until the next pair of digits of the numbers A and B come up for combination. Also, the output of the carry adding gate is used to prevent the passage of a pulse through the threshold "one" adding gate wherever a carry pulse is produced.

Applications of Integrators

As indicated in the introductory paragraphs, integrators are widely used in: Computing applications (4); and Control systems (8).

In computing applications the digital integrator is in the number one position, although there are still many types of computing problems that require the use of analog integrating devices. In control systems, analog integrators are almost exclusively used as yet, but there is little doubt that digital integration will invade this field to increasing extent, especially in relation to "sampling" servo-mechanisms (9). A sampling servo-mechanism is a new type of control system in which the input data is stored in digital form. Their potential usefulness is in controlling machine tools and production processes; for example the replacement of the master pattern used in a contouring machine by a magnetic wire on which the co-ordinates of the surface are stored digitally.

Computing Applications. High speed digital computers have revolutionized the field of mathematical computation. This is not attributed directly to digital integration, because many computing problems require mathematical operations other than integrations to be carried out during their solution. However, large-scale computations would not be possible, if rapid, accurate, and reliable methods of carrying out integrations were not available.

So far as the problem of carrying out an integration in a high speed computer is concerned, use is made of the facilities existing in the machine. No additional or special equipment is required because such computers possess a store, control units, and an accumulator and adder. Integrations are required to be carried out in large numbers in the solution of differential equations. In addition, the production of mathematical tables requires the evaluation of definite integrals of a complex nature. Analog devices for doing such integrations would not be sufficiently accurate, and evaluation by hand computation may well take years to complete.

Although digital computers are being used in increasing numbers, many differential analyzers still exist, and it is likely that there will always be scope for some such instruments, especially for the solution of engineering type problems where the input data is supplied in graphical form and an answer required in similar form.

Typical of the problems suitable for solution on a differential analyzer are railway traction problems and time tables; pondage problems in reservoir design; stability of interconnected power systems; and exploratory solutions of equations of mathematical physics prior to programming for accurate solution on a digital computer.

Special purpose analog computers and simulators cover a wide field of application of the analog integrator. The electricity meter is a simple analog computer; other simple computers are integrating recorders for measuring total hydraulic and gas flow in industrial plants. Another field which uses special purpose computers, ranging from simple integrators to the most highly complex systems, is that of anti-aircraft and naval gunnery directors. In this field complicated mathematical

equations must be solved instantaneously and continuously.

Finally, there is a new and growing field of application for simulators. They are used extensively in engineering design and development work. The need has arisen because of the complex problems arising in design of modern supersonic aircraft and guided missiles. They are special purpose machines in the sense that one machine will be constructed specially for a stability problem in supersonic flight. However, inside their particular field of application, they permit great flexibility for introducing variation of parameters, both internal and external, of the problem under investigation. They even permit certain subunits of an equipment under development being tested operationally before the final completion of the project.

In nearly all of these special purpose and simulator applications the real time integrators find more favor; and in particular, the electro-dynamical and Miller type integrator.

Control Systems. In control system and servomechanism problems, the need for better performance has resulted in the application of integrating and differentiating devices to improve the steady state and transient response characteristics of the system (8). The devices used have been developed in close relation to the servo field in which they are used. In fact, the phase-lead and-lag networks, creeping relays, etc., that have become part of the servomechanism terminology are part of the wider field of computing devices.

In servo application, phase-lag elements are in fact integrators or approximate integrators. Phase-advance elements on the other hand, are basically differentiating elements. It is interesting to note here that while in ordinary analytical mathematics, differentiation is a straight-forward process, and integration is extremely difficult; the reverse is the case in the mechanical computation of derivatives and integrals of a continuous process. Integration is straight forward and involves only a knowledge of the past history of the process. True differentiation requires a prediction of the future, and is therefore uncertain. It is completely balked by a discontinuity. As the differential is the slope of a curve at a given point, jitter and perturbation of the function requiring differentiation leads to a very false instantaneous prediction, and usually some "smoothing" is needed in evaluating a derivative.

Paradoxically enough, the integrator comes to the rescue. It is easy to show that integration is a smoothing process, and by suitable use of integrators in a differentiating mechanism a smooth derivative may be obtained. It has been shown that the best estimate of the immediate future trend of perturbed data is given by a parabolic weighting of the derivatives over an immediately previous time interval. This time may vary from a few milliseconds to several seconds in typical control problems. Suitable interconnect integrators will have a double exponential response which approximates the desired parabolic form.

Electrical networks comprising both integrating and differentiating elements are used for overcoming the inherent inaccuracy of differentiation.

So far as the integrating elements are concerned, all the analog devices mentioned above may be used. The electrical network and hydraulic and pneumatic relays are probably the most commonly employed as they are cheap, operate at lower power level, and are sufficiently accurate for the control system application.

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MORE TITANIUM IN PLANES

ACCORDING TO RECENT SURVEY of twenty-one key manufacturers in the aircraft field, at least 300 percent more titanium will be used by the aviation industry in 1954 as compared with 1952 figures. An impressive example here is Consolidated Vultee Aircraft Corp. which used 5,000 lb. of titanium in 1952 (mostly for developmental work), and 55,700 lb. in 1953. Convair plans to use 89,500 lb. this year, and estimates its requirements for 1955 and 1956 as 736,000 and 2,302,000 pounds respectively.

The survey results left no doubt as to why the manufacturers like titanium. Its combination of lightness and strength was way out in front, with its heat resistance at medium temperatures second. However, these same manufacturers were also emphatic as to their dislikes of titanium. Leading the list was high cost, with delivery delays, and non-uniformity of working properties running a close second and third. As to the latter, the results were significant in that the survey showed that 20 of the 21 firms were actively engaged in experimental work with titanium in 1953. Two other technical headaches indicated at the present time were impurities in titanium, and gage variation.

Designing and Fabricating With

Clad steel is a composite plate—a carbon or low alloy steel backing plate inseparably bonded to cladding of a corrosion-resistant metal. Cladding thickness ranges from 5 to

BUTT JOINTS

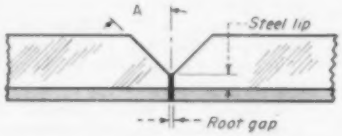


Fig. 1—Single "V" butt joint for material $\frac{1}{4}$ to $1\frac{1}{4}$ in. thick. Angle *A* is 45 deg for material $\frac{1}{4}$-$\frac{1}{2}$ in. thick; 35 deg for $\frac{3}{4}$ in. material; and 30 deg for 1-$1\frac{1}{4}$ in. sections. The lip of steel prevents pickup of the high alloy cladding material in the mild steel weld.

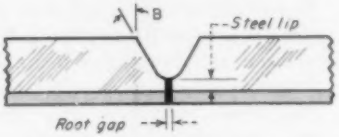


Fig. 2—Single "U" butt joint for material $\frac{1}{4}$ to 2 in. thick. Angle *B* is 10 deg for all thicknesses. The lip of steel should be 1/16-3/32 in. above the cladding for single "V" and "U". Root gap for the single "V" and the single "U" is zero to 1/16 inch.

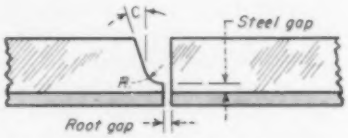


Fig. 3—Single "J" butt joint for material $\frac{1}{4}$ to 2 in. thick. A 30 deg angle is used for all thicknesses. The lip of steel should be 1/16-3/32 in. above the cladding. Radius for "U" and "J" is $\frac{1}{4}$ in. Root gap can vary between zero and 1/16 inch.

Fig. 4—Double "U" or "V" butt joints are used on the heavier gages of material. The center lines of the bevels should be offset to favor the clad side. This will result in the use of lower amounts of alloy weld metal.

Fig. 5—For lighter gages, 3/16 in. and less, the minimum clad should be 20 percent to allow for sufficient cladding for adequate corrosion-resistant welds. For a butt weld, the plate is beveled approximately 70 deg, 5*A*, on the steel side. Where unfused areas will not be detrimental a butt joint, similar to 5*B*, can be used. If a copper backing strip is used, 5*C*, the groove should be 5/32 in. wide by 1/16 in. deep. A $\frac{1}{4}$ in. root gap is used.

TEE AND LAP JOINTS

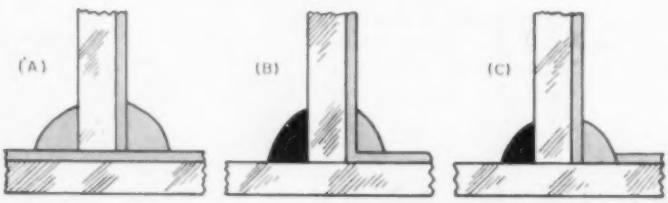


Fig. 1—Whenever possible the steel side should be welded first. When the vertical member is butted to the vertical clad surface, 1*A*, alloy welds must be used. If the clad surface is stripped back, 1*B* and 1*C*, a steel weld can be used on the stripped side as shown.

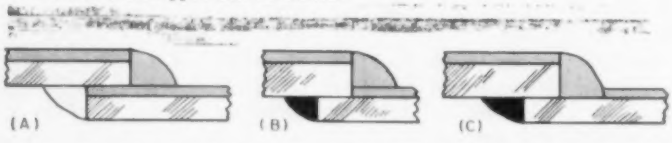


Fig. 2—Lap joints are similar to Tee joints. Alloy welds must be used whenever clad is present. Full alloy welds are needed for the joint of 2*A*. In joints 2*B* and 2*C*, steel welds can be used on the bottom surfaces.

DOUBLE CLAD STEEL

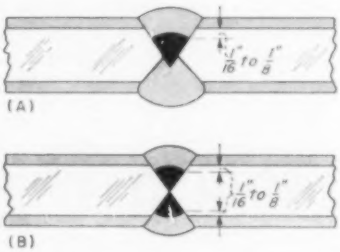


Fig. 1—Two methods are in general use for welding double clad steel. A standard "V" or "U" is made in the plate, 1*A*. A steel weld is made to about 1/16-$\frac{1}{4}$ in. of the clad line, followed by an alloy weld. The unwelded side is then back chipped and alloy welded. On heavy gage plates, 1*B*, a double "V" or "U" is made. A steel weld is made to within 1/16-$\frac{1}{4}$ in. of the clad line and then alloy welded.

Clad Steel Plate

H. F. PETERS
Manager, Technical Service Department
Lukens Steel Company

50 percent of the total plate thickness. Clad plate provides economical corrosion-resistance, abrasion-resistance, and product purity in place of the solid metals of similar analyses.

CORNER JOINTS

Fig. 1—Used on unstressed or heavily supported structures. The top surface and the inside of the joint are welded with an alloy electrode, (A). This type of joint has an undesirable unfused area. Two methods can be used to weld the joint, (B). The clad side can be welded with an alloy electrode. The outside is then back chipped to the diagonal cut and the balance of the joint alloy welded. The second method is to weld the steel side, back chip from the inside, and finish weld with an alloy electrode.

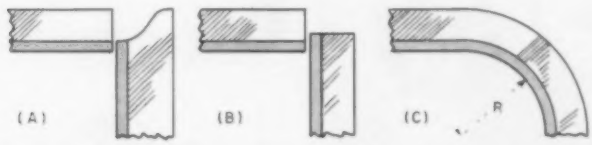


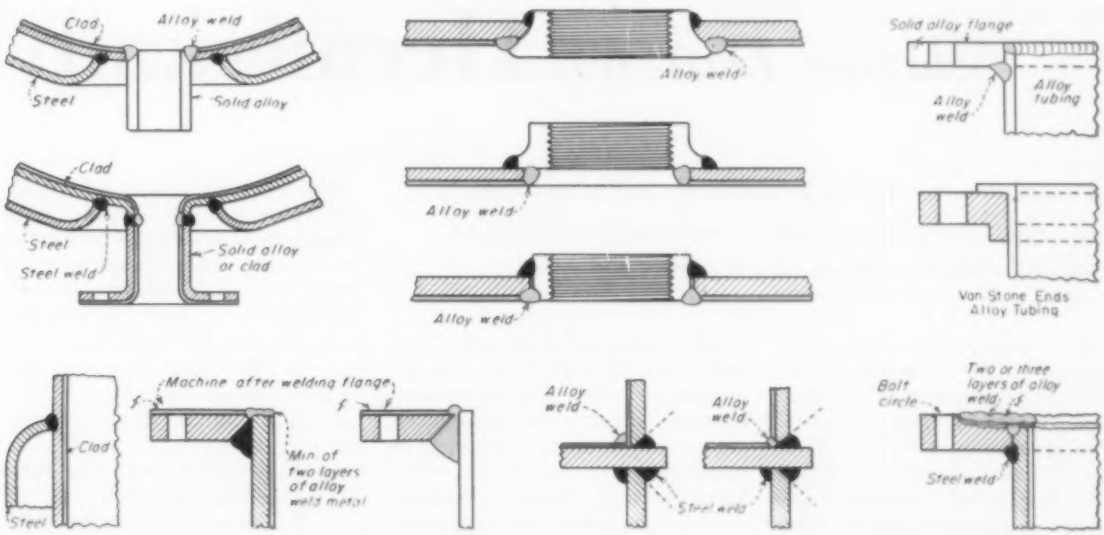
Fig. 2—Joints, (A) and (B), should be welded throughout with an alloy electrode. After welding the clad side, the steel side should be back chipped or ground, and welded with an alloy rod. Whenever possible, corner joints should be avoided and a formed section (C), used. This is more desirable from both a fabrication and structural standpoint.

BLIND JOINTS

Fig. 1—When adequate clearance is available, a copper backing strip is used. When the clad metal is on the blind side the entire cross section of the joint must be welded with an alloy electrode. If the steel section is on the blind side, steel electrodes are used up to 1/16-¼ in. of the clad line, and then finished with alloy.

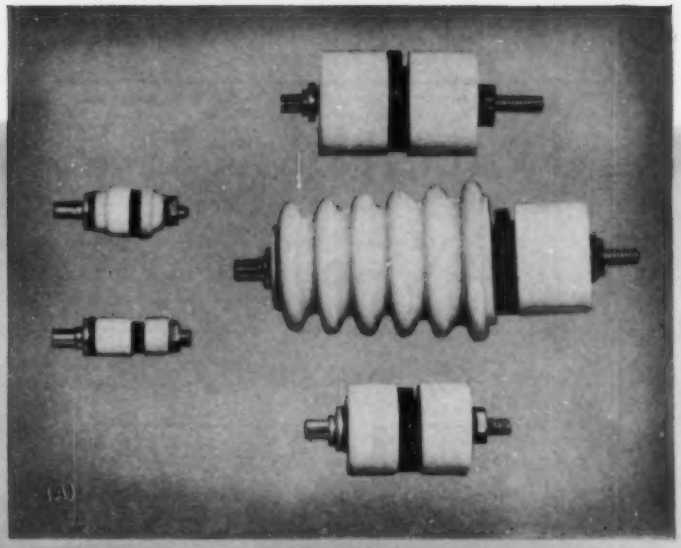
Fig. 2—An alloy backing strip can also be used. When the clad material is on the blind side, a backing strip of the same analysis as the cladding must be used. When the clad surface is exposed, a steel backing strip can be used.

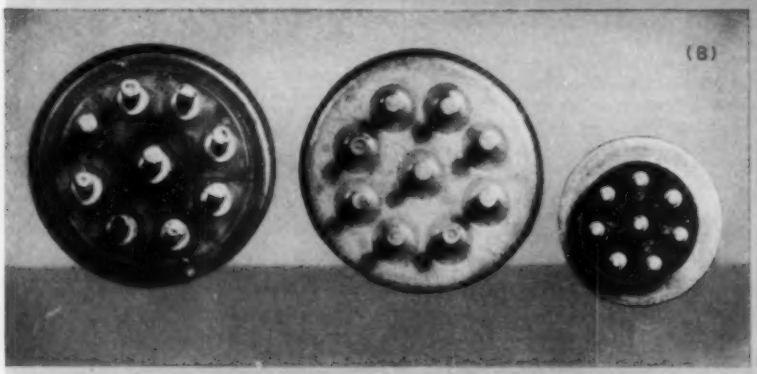
SOME TYPICAL CLAD STEEL ASSEMBLIES



(A) Family of high voltage anchored gasket type terminals. Sealing insert materials include silicone-rubber, Teflon and other elastomers.

(B) Multiple-lead hermetic terminals with molded-plastic insulation. Small unit is molded melamine, center unit is glass covered with Teflon dispersion and long-pinned unit is molded from Kel-F.





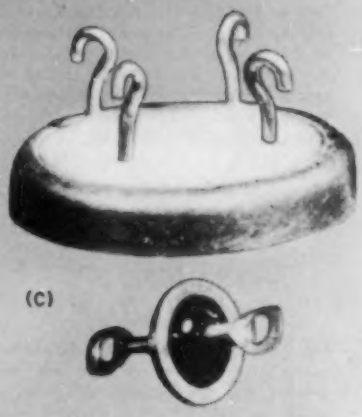


Fig. 1—Types of hermetically sealed terminals.

Selection Data for Hermetically

The use of hermetic sealing of electrical components in both military and industrial applications has created a demand for hermetically sealed terminals of many types and styles.

HERMETICALLY SEALED electrical terminals are used to connect the sealed component to the external source of electrical power or signals. Increased life and reliability are obtained for costly or critical components by protecting fine wires, contacts, joints, junctions, springs and capacitor plates from moisture and by reducing electrolysis, corrosion, leakage and calibration losses. Typical devices that are hermetically sealed and use hermetic terminals include coils, transformers, condensers, rectifiers, resistors, transistors, meters, motors, switches, relays, vacuum devices, controls, servomechanisms, comparators and many other types of electrical equipment.

The four basic types of hermetically sealed terminals, Fig. 1, and variations of each type are included in the following list. Other configurations of these types using different materials are available for specific applications.

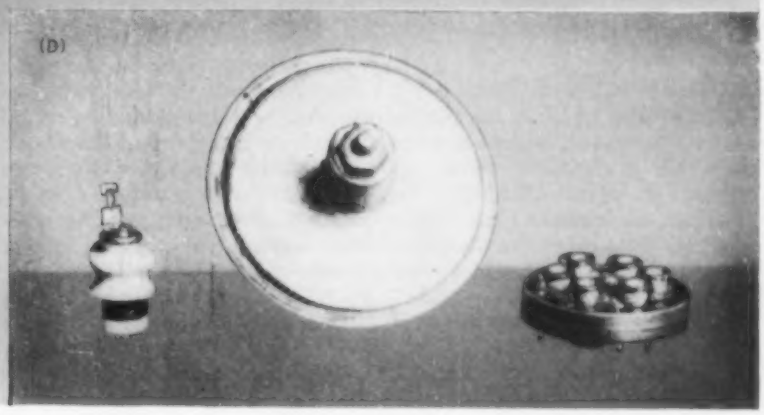
1. Metal-to-glass seals.
   - A. Mild steel to enamel type glasses.
   - B. Nickle steel alloy to matching glasses.
   - C. Refractory metals to borosilicate type glasses.
   - D. Silica glasses to leaded seals.
2. Gasket type seals.

Table I—Performance Characteristics of Hermetic Terminals

Type	Metal-to-glass	Gasket	Solder	Molded Plastic
Temperature range	—60/200C	—80/200C	—60/500C	—50/125C
Shock resistance (Thermal)	Fair to good	Excellent	Fair to good	Good
Shock resistance (Mechanical)	Fair to good	Excellent	Fair to good	Good
Insulation resistance	High	Very high	Very high	High to very high
Insulation resistance versus temperature	Good to Poor	Fair to excellent	Fair to excellent	Fair to good
High frequency merit	Fair to poor	Fair to excellent	Good to excellent	Fair to very good
Leak rate	Very low	Low	Low to very low	Fair

(C) Two styles of glass-to-metal terminals. Multi-lead header has hook electrode and single-lead header has flanged eyelet electrode. Both headers are normally soldered in place.

(D) Solder seal terminals. Unit on left is single terminal seal with hollow lug lead. Center shows inside of header view of composite solder seal plus insert. On right is multi-lead header minus electrodes but showing metal banded beads and rim band.



Sealed Terminals

R. U. CLARK
Chief Engineer, Lundey Associates
Waltham, Mass.

A. Flat ring and "O" ring gaskets.
B. Confined - insert anchored flange types of gaskets.
C. Constricted tubular type gaskets.

3. Metal banded insulators classed as solder seals.
   A. Glass-and-ceramic colloidal metal fired-in, plated and tinned solder banded seals.
   B. Reduced metal-oxide banded alumina, silver fused, plated-and-tinned solder seals.
4. Mechanically molded metal to plastic seals.
   A. Metal electrodes molded in rubber type compounds.
   B. Metal electrodes molded in high temperature resistant plastics.
   C. Metal electrodes of special design force fitted to memory type plastics.

Table I lists the mechanical and electrical properties of the basic types. This table is based on stock terminals; special units in all types can be custom made to give better all around characteristics than those mentioned.

Hermetic seals are used to confine components in gasses such as nitrogen, helium, and freon; and also in various oils such as light mineral oils, chlorinated oils, silicone oils and fluorocarbon oils.

SELECTION FACTORS. Most of the factors involved in the selection of hermetically sealed terminals are listed in Table I. Other important factors are the ease of assembly, space limitations, single or multiple terminals and current carrying capacity.

As indicated, glass-to-metal seals

have the lowest leak rate of any of the seal types. Their other characteristics compare favorably with those of the other seals with the possible exception of insulation resistance. For high voltage use this type of seal becomes a costly item and in many applications it is subject to surface tracking under polarized voltage operating conditions. Glass-to-metal seals can be easily and quickly assembled using soldering and projection welding.

Since the ferrous materials used in glass-to-metal seals have a much higher resistance than copper, care must be taken to use a large enough pin diameter when the terminal must pass more than a relatively low current.

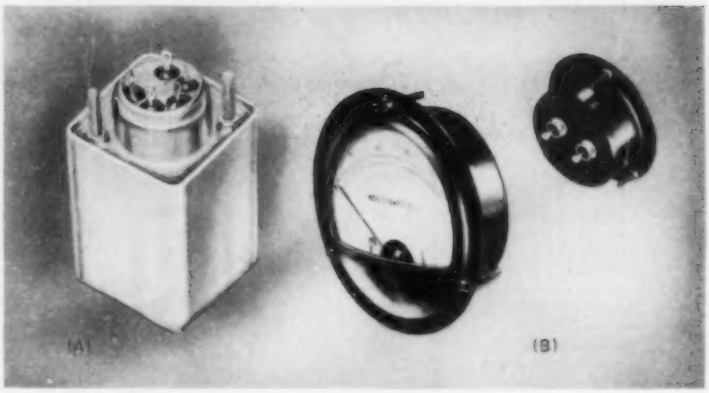


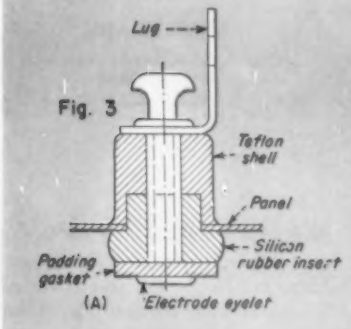
Fig. 2—Two applications of glass-to-metal sealed terminals. (A) shows hermetically sealed relay using multiple lead head. Leads are run through small header or washer-like part. (B) shows hermetically sealed ammeter using single lead terminals.

Gasket Type Terminals

This type of terminal compares well with the other types and can be used in most applications except where very small size is a factor or where high temperature operation and very low leak rates are important. The simplest type has flat or "O" ring washers of an elastomeric material held between two semi-rigid washers of nonconducting material and the member to be sealed off. More popular types are the confined gasket and anchored gasket terminals as shown in Fig. 3. These are known as the single *T* and double *T* type.

In these seals the tubular elastomeric insert or gland has a flange-like section molded to it either near the central portion or at one end of the tube or barrel. The tubular sections may be confined within protecting shells of nearly rigid or rigid insulating material, such as ceramic, glass, plastic or similar materials.

All of the above component parts are either bolted or eyeletted together by a metal piece that forms the electrode of the terminal. This is done so that the resilient insert passes through a hole in the member or panel to be terminated and the flange of the insert is compressed against this member or panel to effect the hermetic seal. By using an insert or gland having good resilience and little tendency to flow (low compression set) and by introducing additional spring loading into the terminal, a hermetic seal of high electrical rating is obtained. Such a combination provides the designer of equipment, which is subject to heavy thermal and mechanical shock, with a means of effectively obtaining those desirable electrical characteristics without in any way sacrificing the required



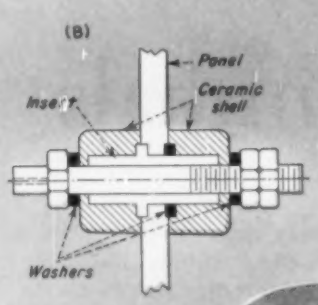


Fig. 3—(A) Modified single *T* gasket terminal. The terminal parts are held together by a metal eyelet and are maintained in compression by a combination of the resilient nature of the gasket and the memory character of the shell. (B) Double *T* type gasket terminal. Hermetic seal is formed by the flange on the insert as it is compressed between the shell and the mounting panel.

Fig. 4—Applications of gasket type terminals. In (A) is shown a hermetically sealed inductor using terminals with internal anchored gaskets and external Teflon insulating shells. (B) shows an hermetically terminated motor using gasket type terminals to feed the power leads through the case.

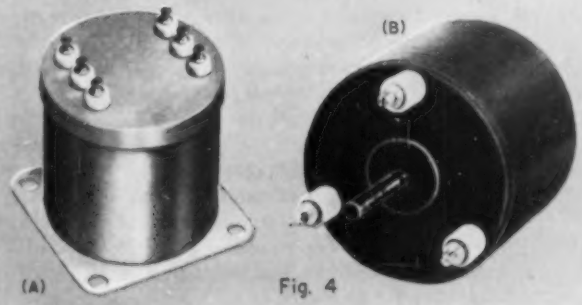


Fig. 4

shock-resistant qualities.

Gasket sealed terminals are available in a large variety of shapes and sizes from ¼ in. dia up and can be easily assembled with low cost tooling. In the larger sizes and where various styles and sizes are used on one panel, the gasket type is most readily assembled. Fig. 4 shows typical applications of this type terminal.

The confined and anchored gasket types break the continuity of the external electrical path in such a manner that conductive "surface tracking" or "plating" on the surface is prevented under voltage polarization during high humidity conditions. For this reason they are used extensively in electronic equipment.

The above characteristic leads to other advantages as well as some limitations. Since the basic insulation of the anchored gasket type terminal is the elastomeric insert, a material can be chosen that has two or three times the dielectric strength of conventional ceramics and glasses. The insert can be encased in the latter bodies without degrading this basic dielectric strength except at the interfacial surfaces. However, these surfaces are usually too long to effect the over-all dielectric rating except where poor fit and contamination of parts are encountered.

The above type terminal has high mechanical shock resistance. By adding solder seal bands at each extremity of the internal ceramic part and soldering one band to the header or panel and the other band to the terminal's electrode, a nonturning vacuum tight terminal can be obtained.

Solder Seal Terminals

Solder sealed hermetic terminals are at least as good as the other types except in their resistance to thermal and mechanical shock. They are the only type that can be used in applications where the temperature consistently exceeds 200 C and are used extensively where electrode diameter exceeds ¼ in. The ease of assembly compares to that of glass-to-metal seals.

One style of solder seal is shown in Fig. 5. This design has a high band strength, a long internal path and a mechanical reinforcing member to reduce stress and strain. Essentially this is a two piece solder seal; however the re-enforcing member which acts as a truss to absorb mechanical shock can be a low cost plastic piece. The banded ceramic part is also a low cost item because of the simple design. This type of construction helps to improve the mechanical shock characteristics.

The plastic reinforced member acts as a baffle and gives a long internal path for a normally short internal path ceramic design. The danger of corona at high voltages is avoided by making the inter-part clearance small. Since the plastic insert contacts only a small area of the panel, the electrical capacity of the terminal to the panel is low and the leakage resistance high. This dual combination permits the use of certain desired types of plastic inserts, such as the melamines, that might otherwise be barred because of high loss factor characteristics.

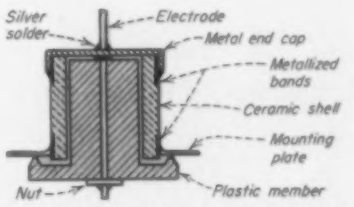


Fig. 5—Solder type hermetic seal designed to improve normally poor mechanical shock resistance of this type unit.

Molded Plastic Seals

The plastic molded types of terminals and headers which include the fluorocarbon resin types, the mica-glass bonded types and other similar constructions have the advantage of simplicity of structure and design, Fig. 6. However, they do not have the impressive service record of the other types of seals and as can be seen from Table I, they are inferior in some respects.

In addition, problems have been encountered in designing the specially shaped electrodes and in obtaining a metal with a coefficient of expansion about equal to the plastic molding compound. However, improved designs are expected in this type terminal since it is available in single or multiple units and lends itself to miniaturization programs.

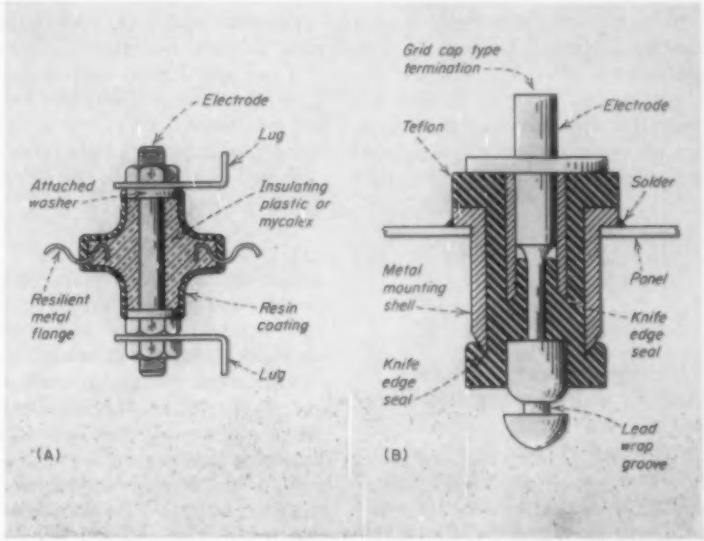


Fig. 6 (A)—Plastic molded type hermetic terminal. Although not field proven as yet, improved design will expand the application of this type particularly in the small multiple pin styles. (B)—Teflon insert memory type seal. Teflon is compressed, not molded, and depends on its memory characteristic for sealing.

Electrode Styles

The mechanics of the terminal electrode and its connecting end configurations are a common problem in the design and application of all types of terminals, Fig. 7. The controlling factors in electrode style selection are:

1. The current handling and operating voltage specifications.
2. The electrode spacing and clearance requirements.
3. The adaptability of the class of terminal chosen to the various types of connections to be used and to the form of lead anchorage desired.

Where space is limited, hollow or eyelet type electrodes are often used.

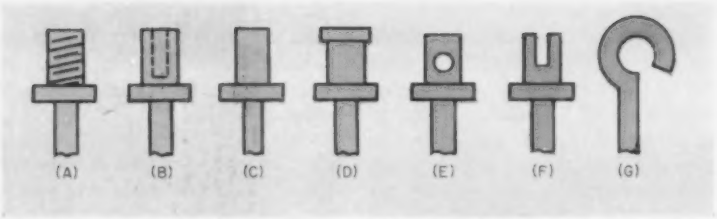


Fig. 7—Popular electrode head styles include: (A) threaded tenon, (B) tubular head, (C) grid cap head, (D) single turret head, (E) pierced head (generally milled flat perpendicular to hole axis), (F) split tenon head, and (G) hook head (most often used in glass-to-metal seals).

In these the lead wires from the sealed off apparatus runs directly through the center of the terminal with the high current contact being made on the outside or external part of the electrode. This electrode design can be obtained in glass-to-metal as well as most of the other types of seals.

Surface Treatments of Terminals

The metal electrode surface finish varies with the operating temperature and environmental conditions. Nickel plate and silver plate finishes are used in high temperature applications. Silver plated electrodes should also be used when they are required to handle high frequency currents.

Other common electrode finishes are cadmium plate, hot tinned, and electrotinned followed by hot oil fusing. The silver finishes are water lacquer dipped to prevent tarnishing, and they and the fused tin present the best surfaces for subsequent easy soldering of leads.

Each of the types of terminals covered here can be given special treatments to reduce or overcome certain inherent deficiencies. Referring to Fig. 6, the electrode and resilient metal flange are molded into an insulating body of plastic. To improve the sealing ability of the terminal a fused-on coat of fluoro-carbon resin is applied. This coat is continuous and encompasses the metal flange seal and the electrode end seals. Another advantage of this coating is that it prevents surface plating and forms a nonporous outside surface. This same kind of treatment can be applied to other seals including the ceramic and glass types.

Terminals for High Vacuum Applications

Hermetic seals have been divided into two categories: hermetically tight and vacuum tight. The first category is used to seal in air or an inert gas under approximately atmospheric pressure against normal ambient conditions of about the same pressure. Vacuum tight seals are used when the sealed unit is evacuated to a high vacuum or when the unit must be continuously operated under low pressure high altitude ambient conditions. Normally only the wetted metal-to-glass and the high temperature refractory metal bonded soldered or brazed seals are thought of as vacuum tight terminals.

For all types of seals, the allowable operating temperature should be chosen within a conservative range based on the published data covering the heat distortion and low temperature qualities of the materials used. Consideration should also be given to the thermal shock characteristics of the parts. A derating of from 25 to 40 percent of the normally published useful rating limits is reasonable.

Methods of Testing Seals

Hermetically sealed terminals are tested for their efficiency as seals and for their electrical characteristics. The seal test methods include:

1. Dip test in hot water (90 to 95 C) where feasible. Entire sealed container is immersed to check for continued bubbles and resistance drop after drying.
2. Exposure to high humidity conditions during a wide range of temperature and vibration cycles. If leakage occurs, breathing and lowered electrical resistance will result.
3. Leakage test using small atom gas. Reading taken with sensitive ionization gages or by mass spectrometer determinations.
4. After assembly in case, immerse the terminal in a fluid with low surface tension characteristics while pressurizing the case at the open end. A leak is indicated by bubbles.

Hermetically sealed terminals are tested for electrical characteristics as follows: 1. Flash over voltage; 2. Leakage resistance; 3. Leakage resistance versus temperature and humidity; 4. Break down voltage; 5. Start of Corona voltage.

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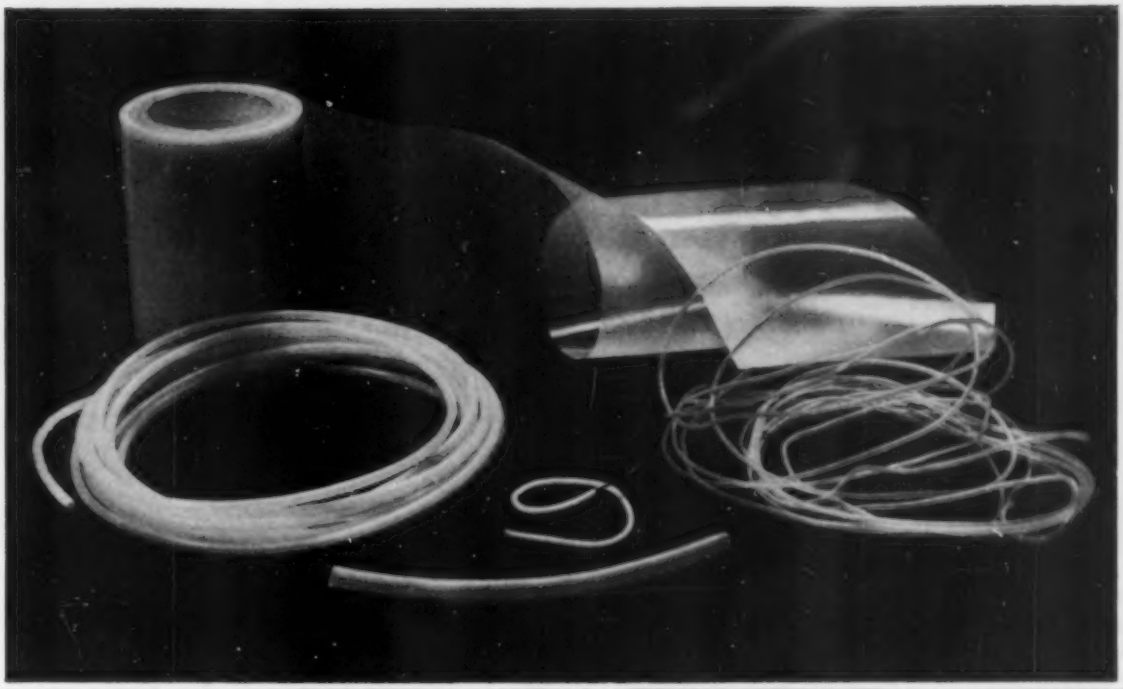


Fig. 1—Parts that can be made by compound extrusion. Tape and small dia. tubing is most often produced by this method.

Producing Teflon Parts

Powder metal methods need no longer be relied on for Teflon forming. New techniques and improvements of older methods permit closer tolerances, higher production.

ROBERT RULON MILLER
Vice President, Dixon Corporation

UNTIL RECENTLY, the technique of forming shapes from polytetrafluoroethylene, or Teflon, was similar to powder metal methods: compressing at 2,000 psi, baking at 700 F, and where necessary, finish machining. However, rapid advancements in the field have developed several new methods and have improved the older techniques of molding and fabricating Teflon.

Four methods are presently being used for the manufacture of Teflon parts, each having its advantages and limitations based on cost, quantity, quality or complexity of the part. These are: (1) Screw machining of rod or tube; a high production method; (2) Compression molding, which is similar to the technique used for the manufacture of powder metal parts; (3) Hot forging, one of the newer methods, used to produce parts of complicated design; and (4) Compound extrusion for fast production of extremely thin sections.

The new techniques allow the forming of Teflon with tapered holes, keyways, thin sections, and angles, Fig. 2, with tolerances up to ±0.001 inch.

GUIDE TO ORDERING, INSPECTING AND MACHINING TEFLON

DO

1—For electrical use order virgin material. For chemical, anti-adhesive or high temperature application a Teflon with a lower specification level can be ordered.

2—Inspect all material for cracks and density. A good check for quality in Teflon is to shave off with a knife a very thin wafer—thin enough to be opaque—from the rod, tube or piece received. Hold this piece up to a light (daylight will do) so the light passes from its source, through the piece. Good Teflon will show a creamy yellow color with many fine lines running through it in various directions. Bad Teflon will be dull, whitish in color, will not be as opaque and will not have the lines.

3—Request colored Teflon when required. It is a simple matter to get any bright color yellow, blue, red, green, brown, black and intermediate shades.

4—Order lengths required. Especially get 10 ft lengths and over for screw machine work.

5—Demand the tolerances required, but remember close tolerances increase cost. Relax any tolerances that aren't needed. It means much less cost and quicker delivery, not to mention savings in mold costs.

6—Demand "stress relieved" Teflon if it is to be used at temperatures over 250 F. Stress relieving guarantees maintenance of tolerances over wider temperature ranges.

DON'T

1—Buy Teflon entirely by price. Cheap material can lack density, be unsintered or poor electrically.

2—Insist on pure white Teflon, especially in extruded stock. A perfectly white piece of Teflon is generally not as good as a slightly greyish or spotted piece. All Teflon can be made white by exposing it to heated air, but this may change the characteristics of the material.

3—Buy rod when tubing should be used, if the finished piece has a through hole.

4—Believe that a part can't be made in Teflon. Today almost everything can be made by one of the four ways outlined in this article.

5—Eliminate Teflon from a product if cold flow or thermal expansion have proved troublesome. Order "stress relieved" Teflon.

MACHINING. The cheapest and best way to produce circular pieces in large quantities is by the screw machining of extruded rod or tube. Tolerances can usually be held to ±0.003 in. by following the normal machining practices.

Purchased rod and tube can be centerless ground to ±0.001 in., which assures close tolerances on the OD. Extruded rod is available in all sizes from $\frac{3}{32}$ in. to $2\frac{1}{4}$ in.; extruded tubing is available in many stock sizes from $\frac{1}{2}$ OD x $\frac{1}{4}$ ID up to $2\frac{1}{4}$ OD x $1\frac{1}{4}$ ID with varying wall thicknesses. Whenever a Teflon part requires a through hole, then tubing should be considered. However, tolerances of ±0.031 in. must be allowed on the ID, prior to machining.

Screw machines are designed for continuous work, so Teflon extruded tube or rod should be ordered in lengths of 10 ft or greater. The use of lengths greater than 10 ft will depend on storage space, handling and shipping facilities. Lengths shorter than 10 ft are not economical for screw machine operation.

COMPRESSION MOLDING. For low production runs, shorter length compression molded stock should be used. Again, where the finished part has a through hole, tubing can be considered. Tolerances on molded sections are easily held to ±0.005 in. If necessary, closer tolerances are possible, but a higher cost will result.

Quantities from one to a thousand or more parts can be finish machined on a lathe. This is usually the best and cheapest method of working compression molded stock and for producing simple shapes in small quantities.

A molding and coining operation is used for intricate shaped parts, Fig. 5. This requires two molds and should, therefore, be used only when machining is difficult and the double mold technique shows a cost reduction. In this method, the part is preformed nearly to shape by compressing Teflon powder at approximately 2,000 psi. The preform is oven-baked and at about 750 F enters a gel state. The part is then removed from the oven, placed in a coining mold and immediately clamped tight. If the mold is cold, and it usually is for small parts, the piece cools quickly and can be removed in a matter of seconds.

Once the proper size preform and coining molds are established, pieces can be produced in large quantities with identical tolerances of about ±0.002 in. Automatic machines turn out thousands of preforms an hour, and rotary press tables can handle the coining operation of packing rings at a rate of 10 per minute, Fig. 3. The same packing ring could be produced in a single cavity mold at a rate of 2-3 per minute.

HOT FORGING. This is one of the newer techniques of molding Teflon and is an extension of the coining process. It is used to produce pieces

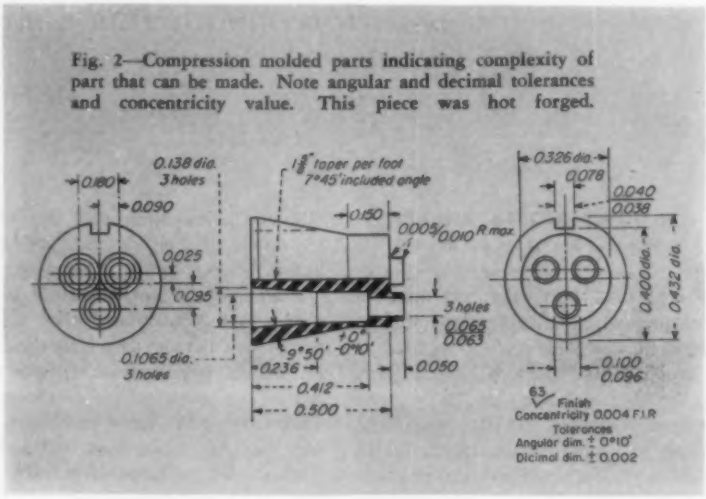


Fig. 2—Compression molded parts indicating complexity of part that can be made. Note angular and decimal tolerances and concentricity value. This piece was hot forged.

of relatively complicated design. The method depends on the flow of Teflon powder. Until recently it was felt that the forced flow of the powder sheared the individual particles of Teflon, thus causing weak spots. This shearing action does not take place when the Teflon powder is force flowed at 750 F.

Hot forging consists of taking a piece of Teflon of the same cubic capacity as the finished part but otherwise totally dissimilar, heating it to the gel state at 750 F, and then transferring it to a hot mold, which forges the heated material to the final shape. Any size piece can be hot forged provided the necessary press tonnage is available. A maximum pressure of 2,000 psi is used. Like the coining process, this is a two mold procedure —one mold to form the pre-forged piece and one to actually do the forging. Quantities should range in the 5,000 piece category, or the design be intricate enough to warrant the double mold price. In Fig. 4, the diaphragm is hot forged to firmly anchor the stud in the Teflon. Such parts can be comparatively complex, and tolerances can be held to ±0.001 inch.

Hot forged pieces should not be used at temperatures greater than 250 F. Above this temperature, the part will usually revert to its normal or original shape. The change is commonly called "plastic memory". Stresses set up in the material during the hot forging process are released when the piece is heated again. This relieving starts at around 250 F and is complete at about 500 F.

COMPOUND EXTRUSION. This technique, the newest and the most unusual method of fabricating Teflon, produces material in film thicknesses from 0.004 to 0.125 in. Spaghetti tubing, tape and shapes with extremely thin walls can be extruded at a rate faster than normal for Teflon. Any extrusible shape can be made with a wall thickness of not greater than 0.125 in. (Fig. 1).

Teflon powder is tumble-mixed with 25 percent. Naptha-Vistinex extrusion aid to form a sticky, powdery paste, which smears into sheet when rubbed between the fingers. The paste is preformed under light hand pressure and is inserted into a cavity that has a nozzle at its lower end. The preform shape depends on the finished section. Spaghetti tubing is extruded from a round preform and tape from a rectangular shape. A ram, pushed through the top of the cavity, forces the paste through the nozzle, which is formed to the desired shape, beading or tubing. The formed material passes through an oven at 500 F, driving off the Naptha-Vistinex extrusion aid, then enters a radiant heat oven at 1,200 F from which the material emerges sintered and ready for use.

Compound extrusion allows tubing to be produced with walls as thin as 0.004 in. Tape and beading, usually skived from large molding cylinders, can now be produced directly. Paste extruded tape has fewer pin holes and better electrical properties than skived tape. Tolerances on some tubing and beading can be held to ±0.0005 inch.

The techniques of hot forging and compound extrusion are assisting in the discovery of new uses and applications for Teflon. Complicated shapes and very thin sections have always been difficult to machine and were not considered economical. But now, forging and extruding present an economical means of producing these parts.

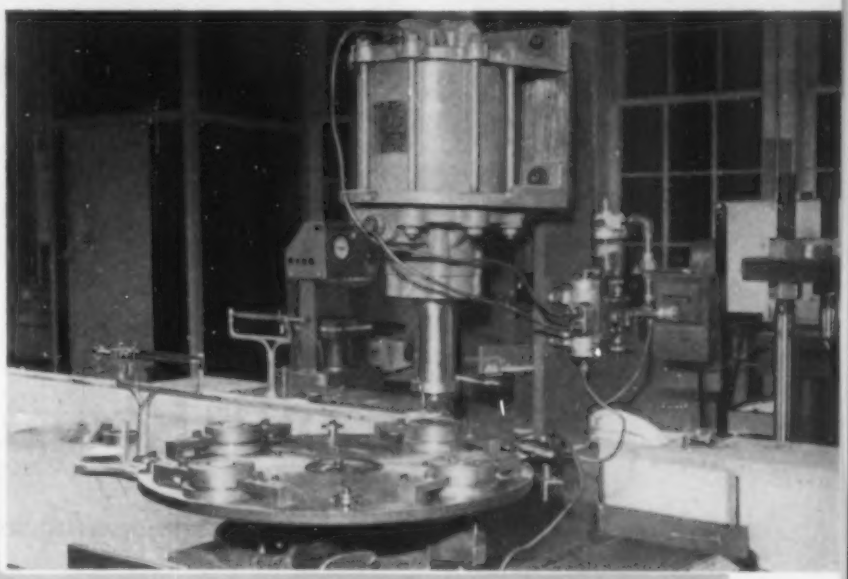


FIG. 3—Automatic four cavity press table capable of producing packing rings at the rate of 10 per minute. Automatic tables should be used for production of 5,000 pieces or more.

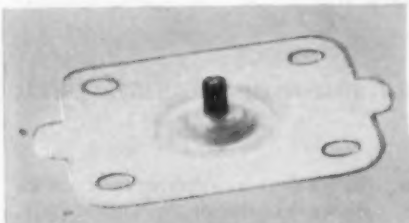


Fig. 4—Hot forged diaphram. Hot forging insures against porosity and gives this particular piece great resistance to wear and cracking caused by flexing.

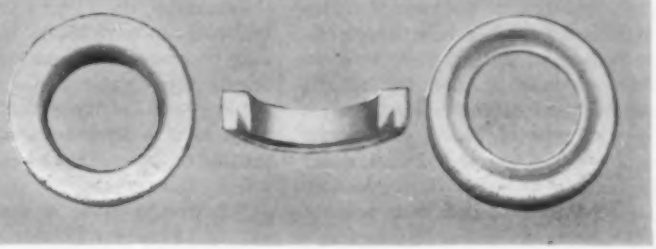
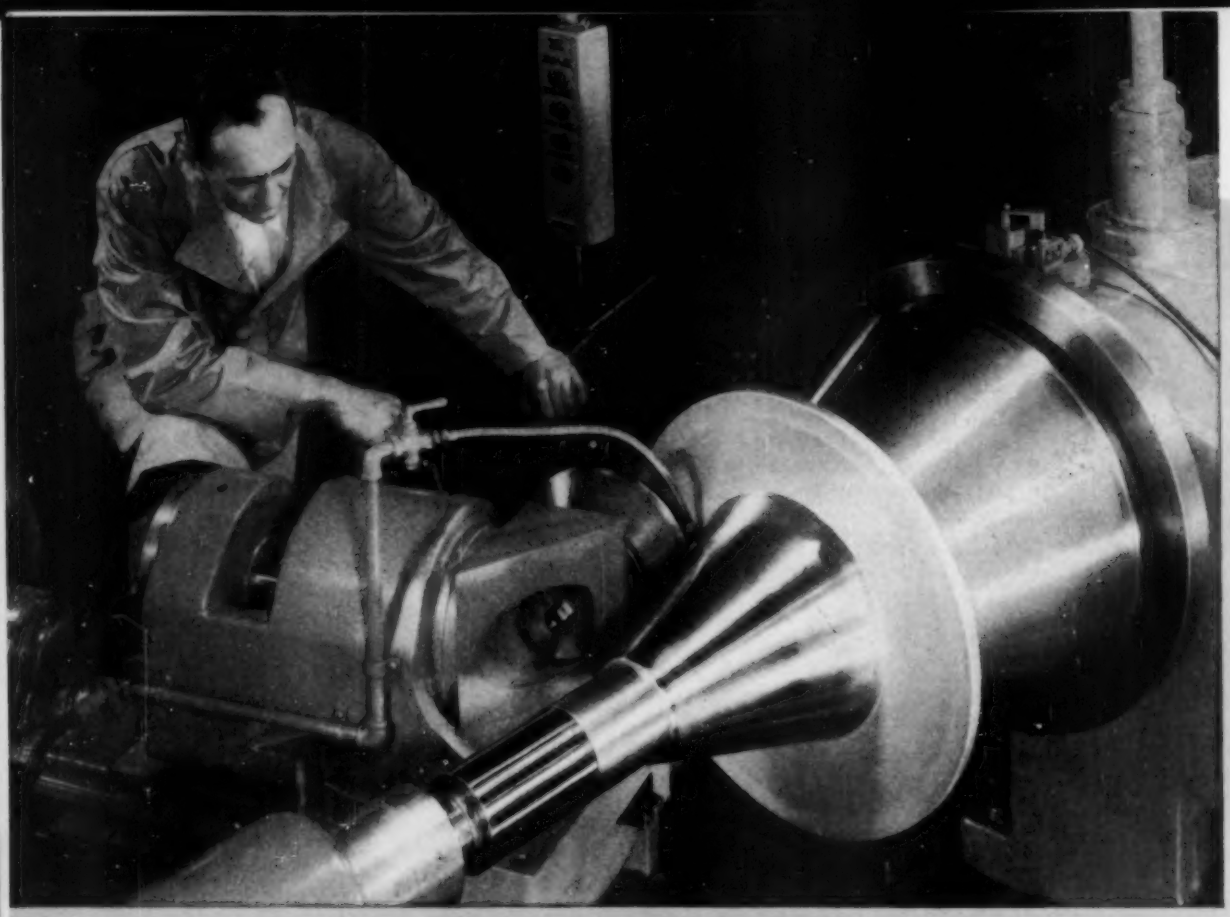


Fig. 5—Packing gasket originally compression molded from rod. Part is an excellent example of piece that can be made from tubing on a screw machine.



ROLL FORMING a jet engine exhaust cone by the Floturn process. Diameter of blank does not change as roller cold flows metal blank to shape of mandrel on lathe spindle. Flange can be left at open end of cone, by stopping roll carriage, or full cone can be produced. Materials that can be worked range from soft aluminum and copper to high strength stainless steels.

New Cold Forming Process

Combination of roll forming and spinning produces parts

CLAUS L. SPORCK
The Lodge & Shipley Company

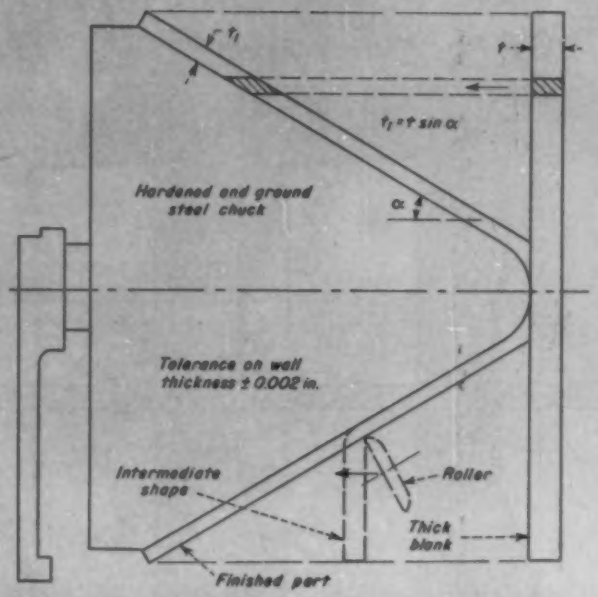
COLD FORMING of symmetrical hollow cones and cylinders from simple flat or preformed metal blanks with the Floturn process involves the application of sufficient pressure to cause the metal to flow tightly against a hardened mandrel on which it is revolved. Pressure is applied with the rounded edge of a hardened and polished roller, 8-10 in. in dia, traversed at a constant rate along the work so the part is formed gradually along a helical path.

Essentially, the Floturn process can be likened to conventional metal spinning processes—but there are some essential differences.

No metal is removed from the blank as it is being formed. Instead, the metal is squeezed ahead of the roll to elongate the part.

Whether spinning is done manually, or with power in spinning lathes, the blank is considerably larger in diameter than that of the finished piece, and the metal is folded against a revolving mandrel or chuck. Only moderate pressures are used, and the blank seldom is thinned appreciably during the operation. Often a number of forming cycles, each with repeated passes of spinning tools, and anneals, are needed to form even simple shapes. Furthermore, spun parts usually lack uniformity, and production rates generally are slower than can be per-

METAL IS DISPLACED horizontally as the pressure roller traverses a path parallel to the mandrel surface. Metal is thinned as shown; a section of original thickness t is reduced to t_1 according to equation, $t_1 = t \sin \alpha$. Maximum reduction in wall thickness is about 75 percent.



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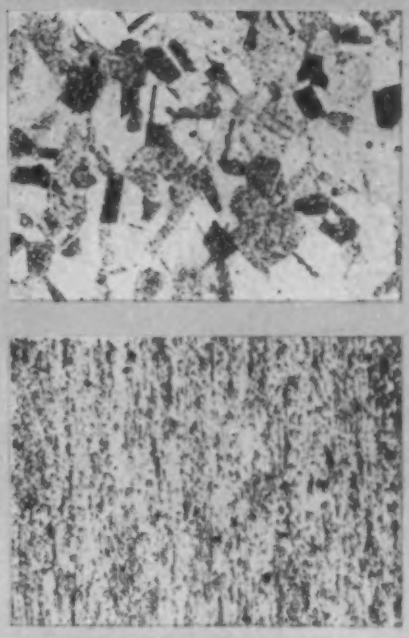


MICROSTRUCTURE of original material (top) and "flowed" metal (bottom) shows refinement of grain size of type 302 stainless. Tensile strength was doubled.

Saves Time and Material

difficult or impractical to make by deep drawing.

mitted by modern standards.

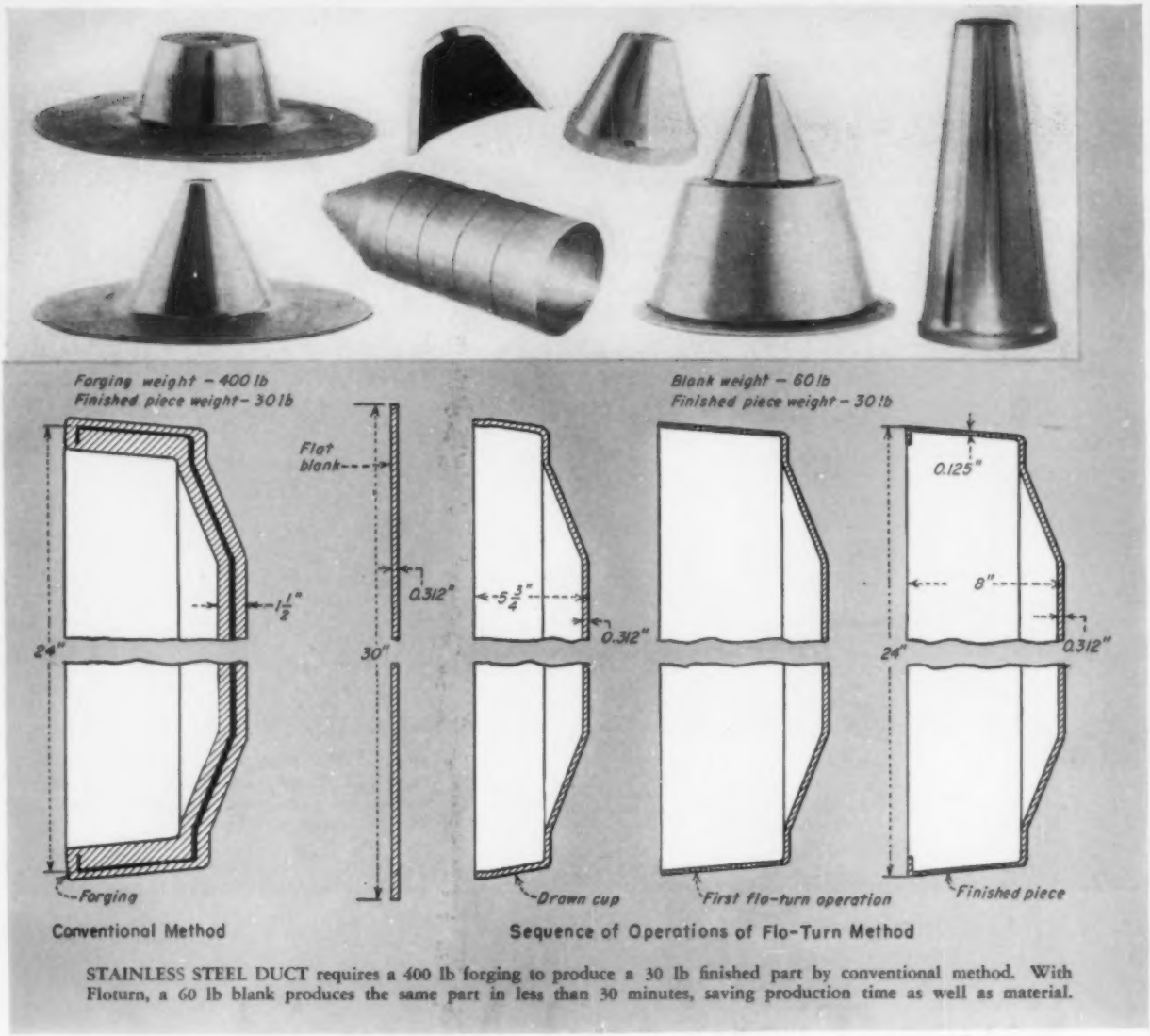
With the Floturn method, however, the diameter of the blank is exactly that of the finished workpiece, and blank thickness is considerably greater than finished wall thickness. The metal in the portion of the blank squeezed between the roll and the mandrel is displaced by plastic deformation as the roll advances, extending the length of the blank until the workpiece is formed to the shape determined by the mandrel. Skilled operators are not needed, as when spinning.

To the design engineer, the important aspects of this development are.

1. *Metal conservation.* This is particularly important in applications such as jet engine components that were formerly machined from forgings. For example, one part that was analyzed recently weighed 50 lb when finished, but, with all the necessary allowances, the forging weighed 369 lb. With Floturn, a 65 lb blank produces the same shape. Disregarding the question of availability of critical alloys, this meant a saving in material alone that amounted to $228.00 per part.

2. *Production of complex shapes.* Many contours that are difficult or impractical to produce by conventional methods now can be made with comparative ease. Where a cone and cylinder once had to be welded into an assembly, a single blank is now "flowed" into the same shape.

Since the metal ahead of the roll is



STAINLESS STEEL DUCT requires a 400 lb forging to produce a 30 lb finished part by conventional method. With Floturn, a 60 lb blank produces the same part in less than 30 minutes, saving production time as well as material.

not disturbed, it is a simple matter to have a flange on a part of the thickness of the original blank. This is done by stopping the traversing motion of the roll carriage at the appropriate point.

Reductions in wall thickness in the finished section can be 75 percent and more even with some of the hard-to-form metals. Some difficulty generally is experienced when attempting to close the metal in too rapidly. For example, it seldom is practical to form a cone with an included angle less than 30 deg in one pass. When such forms must be made, it is better to preform the blank to an intermediate shape, or make two passes.

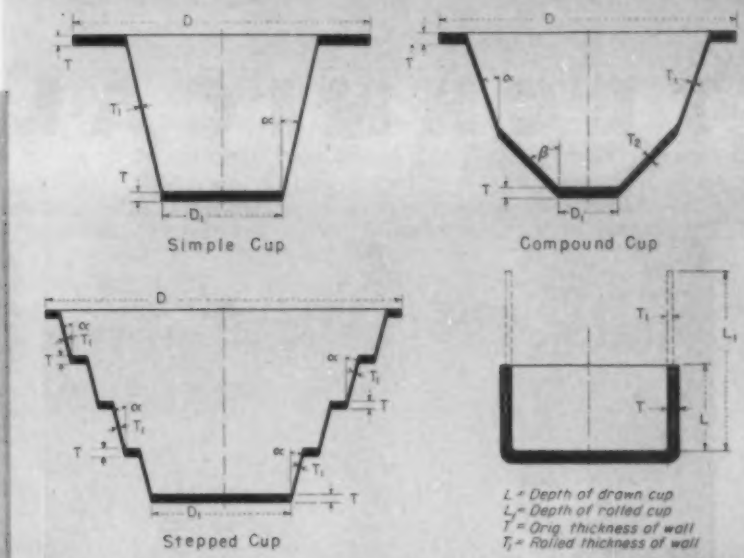
In fact, this is one of the factors that are responsible for the flexibility of the process. The blanks from which finished parts can be made include: (1) flat disks (round, square, hexagonal, etc., depending upon the shape of the flange to be left at the end of the part, if there is one), blanked or sheared from rolled stock; (2) cupped blanks made by coining or drawing; (3) shaped cylindrical blanks machined from forgings; (4) centrifugal castings or press-formed shapes; and (5) cones or cylinders made by wrapping and welding sheet or rolled stock.

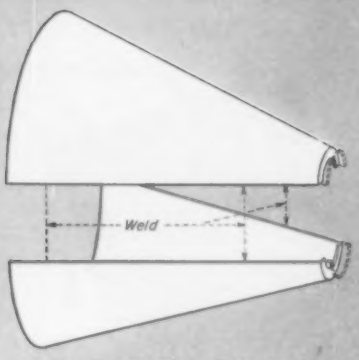
Further flexibility is supplied by the range of materials that can be used. Most types of steels whether from sheet, plate, bar stock or forgings can be formed as well as the following other materials: all 300 and 400 series stainless steels, Timken 16-25-6 and 17-22S, Haynes Multimet, Universal Cyclops Uniloy 19-9, Inconel and Inconel X, Titanium TI-140-A, aluminum and copper. The thickness of blanks that can be used varies from about $\frac{5}{128}$ in. for the harder materials, up to $\frac{1}{2}$ in. for metals such as mild steel, brass, copper and aluminum.

3. *Property changes.* Because it is a cold-forming process, Floturn can cause significant changes in the physical properties of the metal being worked. For example, some recent tests on type 302 stainless steel parts

THICKNESS of side walls of simple, compound and stepped-cone cups depends on thickness of blank, wall angle (½ included angle of cone) and setting of roll relative to mandrel. Formulas are: $T_1 = T \sin \alpha$ and $T_2 = T \sin \beta$. Dia of cup bottom D_1 is 0.5 in. minimum. Deep-drawn cylindrical cups can be reduced as follows:

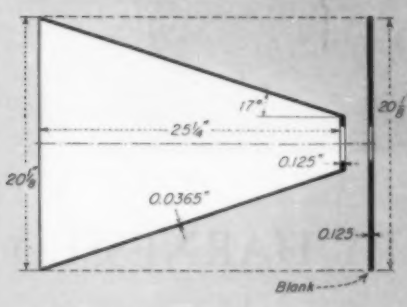
$$L = L_1 T_1 \div T.$$


Simple Cup
Compound Cup
Stepped Cup
L = Depth of drawn cup
L1 = Depth of rolled cup
T = Orig. thickness of wall
T1 = Rolled thickness of wall

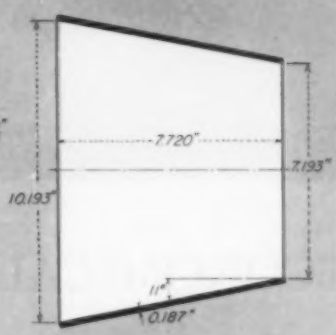


(A) Conventional Method

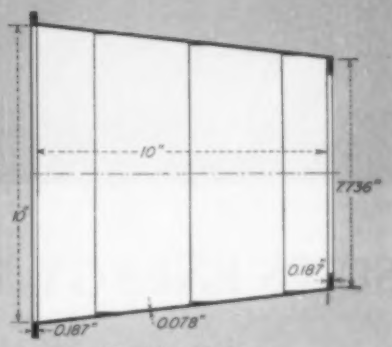
INNER EXHAUST CONE (A) was made by forming and welding stainless. Floturn process (B) makes a stronger part. Reduction in metal thickness, 72 percent. Wrapped and welded cone (C) is the blank for flanged part (D) with steps in bore. Conical blank was flanged at small end in press, then flow rolled to thin the wall.



(B) Made by Flo-Turn Process



(C) Blank (Wrapped and Welded Cone)



(D) Finished Cone

formed by this method showed that the tensile strength had been increased almost 100 percent while hardness increased from that of cold rolled annealed stock to 57-59R30N. Even after stress relieving, the increase still amounted to about 40 percent.

Furthermore, the direction of cold working—a continuous line that becomes a spiral along the entire length of the part—leads observers to expect higher resistance to radial loads.

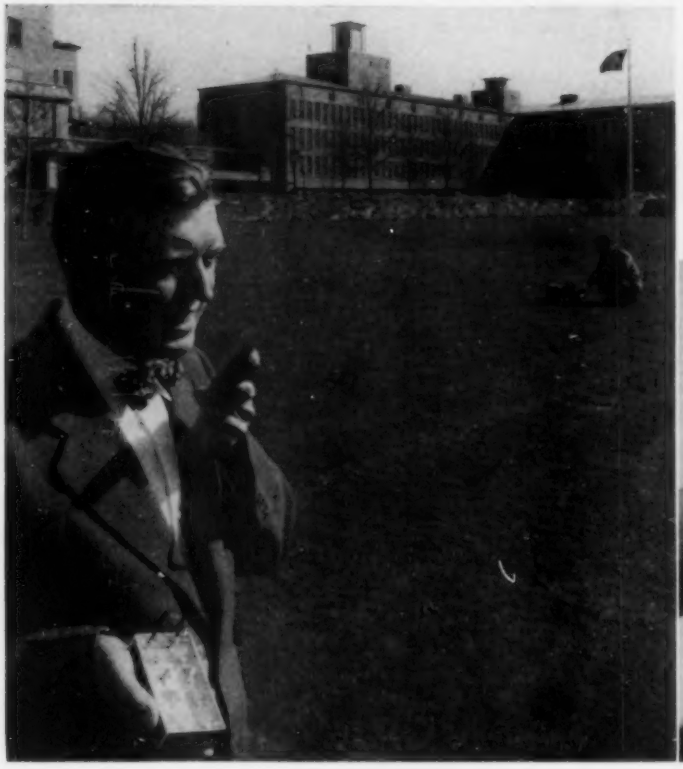
With blanks formed and welded from flat stock, the extreme cold working increases the physical properties of the metal in the weld area to those of the parent material. Finished parts made from this method therefore are much stronger than welded assemblies of formed sheet metal parts.

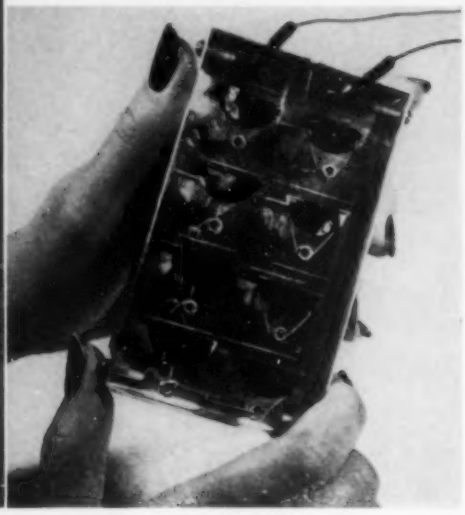
4. *Accuracy.* The diameter of the blank is exactly that of the finished part. In many cases, the part can be produced to finished dimensions in a single pass. Tolerances on wall thicknesses can be held to plus or minus 0.002 inches. When extreme precision is required, 0.015—0.020 in. may be left for machining. This combination of forming and machining offers the most potential for industrial as well as military applications.

5. *Cost.* Obviously, the economics of this new process are closely allied with the application being considered. On one hand, it may not be able to compete with deep drawing where the number of parts involved is so large that die costs are readily amortized and the design, strength and materials make deep-drawing satisfactory. On the other hand, there is the jet engine application mentioned previously for which $228.00 was saved per part on material alone. Similarly, in another jet component, the total tooling cost was less than that of just the welding fixture previously required.

Since the process is still in its infancy, it will be some time before complete cost data are available. At present, important savings that have been realized come from conservation of materials and lower tooling costs.

TECHNICAL NEWS





BELL'S SOLAR BATTERY powering a small portable radio transmitter. With no moving parts, and nothing consumed or destroyed in the energy conversion process, theoretically, the battery should last indefinitely. This is not true of the Atomic battery, also made of a transistor, which deteriorates because of the bombardment of the radioactivity necessary for operation.

SUN'S ENERGY ECONOMICALLY HARNESSED

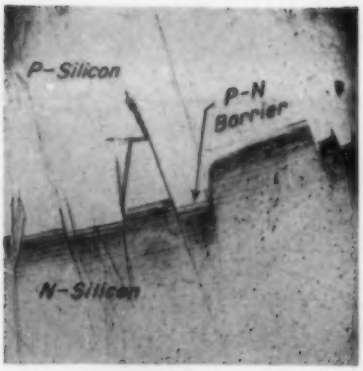
ALTHOUGH THE SUN SUPPLIES over a thousand trillion (1,000,000,000,000,000) Kilowatt hours of energy daily, man has never been able to convert more than a small fraction of this energy to use. Now, scientists at Bell Telephone Laboratories, using a simple-looking apparatus made of strips of silicon, have converted the sun's energy directly into electricity to power the transmission of voice over telephone wires, a transistor radio transmitter, and other devices. Linked together in series, these silicon strips can deliver power from the sun at the rate of 50 watts per sq. yard of surface.

Bell claims a 6 percent efficiency with their Solar battery, which is contrasted with other photoelectric devices never rated higher than 1 percent. With improved techniques this efficiency can be increased to 10 percent or a little better, but the maximum will be 22 percent, a figure limited by the metal itself.

The operation of the silicon Solar battery depends essentially on one feature known as the "p-n junction." (These p-n junctions, built into germanium single crystals, are the basis for the junction transistor.) The battery, and other silicon devices which Bell has in mind, perform in ways that would be impossible for germanium; however, these unique properties depend on the substitution of silicon as the crystalline material in which the p-n junctions are made by the controlled introduction of traces of impurities.

From work with germanium, Bell scientists figured that p-n junctions built into very pure silicon single crystals would perform many functions for which germanium was not well suited; i.e. computers and switching elements, solar energy conversion, and all kinds of transistor action at higher temperatures.

The technique used for the preparation of these junctions was to diffuse the impurities into the surface of a silicon wafer. This wafer is made of completely pure silicon with the exception of a small amount of phosphorous which has been introduced to produce the n-type impurity. This wafer is then heated in the presence of a vapor, in this case boron for the p-type impurity, which covers the surface of the silicon, and diffuses less than 0.0001 in. below the surface. In this way, p- and n-type layers of controlled thickness are formed, and the result is the p-n barrier shown in the photomicrograph above, next page.



A PHOTOMICROGRAPH showing the p-n barrier in a cooled ingot of silicon containing boron and phosphorus.

Bell figures that with the success of the Solar battery, they can use it to charge batteries during the day for night, or the standby power needed in event of local power failure, thus saving much of the expense for motorized standby equipment. As for large scale power production, though, an industrial size 30,000 kw plant would require about 60 acres.

COLOR TV GETS BIGGER

THE ALLEN B. DU MONT LABORATORIES just announced the development of a 19-inch color television picture tube that will be available for public use in a limited quantity late this year. Du Mont says that the price for the complete 19-inch TV set will be the same as the present 12-inch set ($1,000-1,200), but that within two to three years the price should be down to $400 to $500.

Realizing that a color television receiver is worthless without color broadcast, Du Mont announced at the same time a color Multi-Scanner, that will permit the telecasting of 16 mm color film. This will allow small stations to originate color programs without buying the necessary expensive color cameras and related equipment. And through a new technique known as electronic masking, the color of any particular scene may be varied to add to its quality, thus, grass can be made greener, skies bluer, and roses redder. Also, by this method, differences between films can be allowed for. A duplicate kodachrome, for example, needs more masking than an original.

SCRAP METAL RESCUED

ALL OF THE SCRAP TITANIUM found at the Glenn L. Martin Co. is being turned into profit as a result of one of their latest developments. By resistance spot welding a thick stack of these sheets submerged in liquid, a solid ingot of virgin metal is formed which is at least as strong as the parent metal. The ingot can then be machined into aircraft hardware, or parts. Because titanium costs up to $20 per pound, and sells as scrap for one dollar a pound, the savings are obvious.

The Martin process is basically unchanged from the normal method of resistance welding, but by adding a tank to the machine so that the two electrodes and the material to be welded meet in a liquid, its capacity is increased six-fold. Usually, when the metal was stacked more than an inch thick, it would oxidize, and become hot enough to warp. By performing the welding cycle with the cooling effect of a liquid, the thickness was increased to 6 in. for titanium, and 3 in. for stainless steel. Martin engineers are looking forward to the day when they will be able to produce long ingots by this process using resistance seam welding in liquid.

Another application being considered is in heavy bomber wings that are made of thick rolled metal. Rather than pay for a whole sheet of specially rolled material that is later machined at great cost in time and money, many sheets of titanium could be welded together to form step laminates roughly approaching the taper required. These can then be machined to the exact taper in much less time. Going further, Martin sees the day when it will be possible to form whole wings by this process. The wing skins will be laminated and machined, then welded to the formers, spars, and major assemblies, and finally welded together to form the whole wing.

In tool engineering, built-up tools, now machined from bar stock, can be fabricated from resistance spot welding of laminated sections in varying thicknesses.

Briefly, the procedure is this: the sheets are deoxidized in an aqueous solution of 2 percent hydrofluoric acid and 10 percent nitric acid. A 400 KVA three phase welding machine is used with Mallory 3 electrodes, 2½ in. in diameter. The cooling tank is 24 in. square and 8 in. deep. The bottom electrode protrudes into the bottom of the tank, and the top electrode is submerged in the liquid.

To test the strength of the laminate, it was machined to a standard ASTM tensile test specimen, and tested. The results are listed along with those of the parent material. Tensile strength: 92,000 psi, parent material 80,000 psi; Yield strength: 73,700 psi, parent material 70,000 psi; elongation 17 percent, parent material 15 percent.

EIGHTY-NINE SHEETS of titanium that have been resistance spot welded in solution to form a solid stack 6 in. thick. Martin also welds stainless steel in thicknesses up to 3 inches.

A STACK OF sheet stainless steel being welded in a tank filled with a liquid coolant. In the future turbine wheels and blades may be fabricated as one integral unit by the resistance welding process.

Magnesium in Jet Aircraft

THE USE OF MAGNESIUM in jet aircraft has not progressed as far as was predicted five years ago. It was then said that after the pressure was off the production for combat planes, there would be a tremendous change over from aluminum to magnesium. That change has yet to be made.

However, according to Charles De La Haye, of McDonnell Aircraft Corp., the picture is not as black as it may seem. The prediction was recognized even then by design engineers as fantastic, so the progress that has been made is still considerable.

There are several basic reasons why the use of magnesium has not reached the predicted heights. There would not have been sufficient magnesium to take care of the demand had the change been made. Even now, with only a relatively small amount of magnesium being used, it is not always readily available. Sheet stock can be picked up in some sizes, but castings and forgings are running several weeks longer on their delivery time than aluminum. Even though magnesium has a high machinability index, the change over in tooling for magnesium has not been easy. Many precautions have been found necessary, especially in exercising safety, as magnesium is rated as a fire hazard.

Forming magnesium sheet in many cases requires the hot form process. This requires expensive dies and setups for a relatively small quantity, making the cost somewhat prohibitive. Also, the weight-strength ratio of magnesium to aluminum is not favorable to magnesium in most instances.

In spite of these and other apparent drawbacks, the great weight reduction afforded by the use of magnesium has forced the jet aircraft designer to investigate all possibilities for its use.

Use of Magnesium Sheet

In magnesium sheet, the aircraft designer seems to have found magnesium's most extensive use. There are many sheet metal doors which are non-structural and can be made in light gages with extruded magnesium doublers and stiffeners spotwelded to them.

Forming sheet magnesium in the more intricate shapes requires expensive heated dies. In many cases the forming must be done in two or more stages as compared with only one for aluminum. Lubrication of the sheet and the dies has always been a problem since the effectiveness of the lubricating compound is often affected by the heat. Magnesium spotwelds easily and its inherent stiffness helps the door assemblies to retain their smooth shape.

In sheet metal assemblies, those using magnesium, one of the more difficult assembly problems arises—that of dissimilar metals. Galvanic corrosion is very active where magnesium and a dissimilar metal may come in contact, and vinyl plastic tapes and paints must be used to prevent this corrosion.

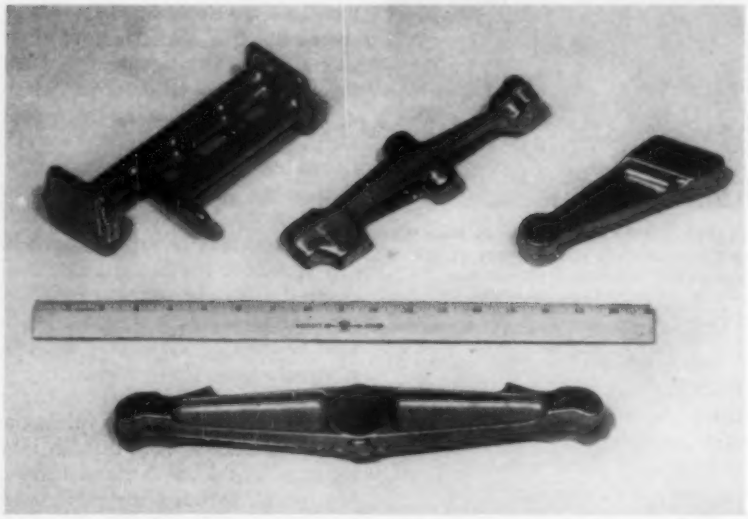
Corrosion from salt air and sea spray almost prohibits the use of magnesium on the exterior of Navy jet aircrafts. Another problem is being encountered in the finish of the outside of planes that are being left a natural aluminum finish. Magnesium results in an "off" color and must be painted with aluminum lacquer to conform to the rest of the plane.

Costwise the magnesium sheet is its least expensive form, and as such will be given study toward future applications.

Look for the extended use of magnesium sheet in non-structural applications where its stiffness and smooth contour added to the weight saving far overcomes the high material cost and expensive fabrication.

Magnesium Castings

In jet aircraft, the use of castings of all materials has fallen somewhat behind the aircraft industry as a whole. Critical strength requirements preclude



SO FAR MOST MAGNESIUM FORGINGS have weighed less than five pounds. Where minimum wall thicknesses are stronger than is necessary, magnesium forgings can be used to advantage, due to the weight saved.

PRESS CAPACITY FOR FORGING MAGNESIUM ALLOY

ALLOY	15,000 Ton	35,000 Ton	50,000 Ton
AM65S	750 Sq. In.	1,700 Sq. In.	2,500 Sq. In.
AMC58S	425 Sq. In.	1,000 Sq. In.	1,400 Sq. In.

the use of castings in many cases. Where castings can be used, it has been found most profitable weight and strengthwise to use magnesium in place of aluminum. This is apparent as statistics of new designs show 80 percent of the castings are magnesium.

Magnesium Forgings

At present, the very limited use of magnesium forgings in jet aircraft is due mainly to the lower strength to weight ratio and lower modulus of elasticity in shear (Modulus of rigidity) as compared to aluminum.

Larger presses are required in the production of magnesium forgings. Defective forgings cannot be restruck, as the resulting grain structure lowers the critical mechanical properties.

Trimming with dies is not practical and the magnesium forgings must be sawed to remove the flash and trim.

Forging magnesium is much slower than forging aluminum, and more pressure is required per area as compared with aluminum. At present, press capacities are a limiting factor in the size of forgings that can be produced in magnesium. The chart, left, shows the press capacity for two magnesium alloys used in jet design.

Says De La Haye, "If a new prediction were to be made as to the future use of magnesium, it would not yet be as optimistic as was the prediction made five years ago. But it would be one based on a wider knowledge of the material and its use."

FUSED EDGE FIBER CUTS PRODUCT ASSEMBLY COSTS

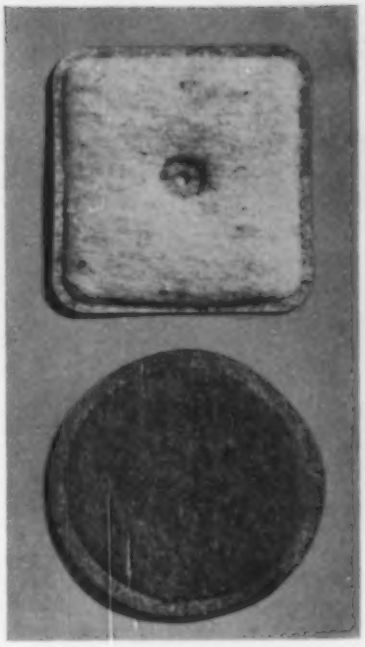
TWO OF THE MAJOR TYPES of bonded fibrous structures are "wool felt," in which the felted and interlocked wool fibers act as the bonding medium, and "bonded fabrics," in which thermoplastic synthetic fibers or chemical impregnations serve as the bonding medium. The latest development by the American Felt Co. permits the bonding of parts in multiples of individual units rather than flat yardage form. Called "fused edge" parts, these fibrous products can be made in specific shapes and sizes with only partial areas of the structure bonded or molded to shape.

The starting fibrous structure in this case must contain percentages of thermoplastic binder fibers, making it possible to bond all portions of the structure into a single member. The dies not only compress and mold, but cut out multiple of finished parts at the same time. The soft or unpressed sections of the piece can be designed to retain any required porosity.

The main idea behind the development of the "fused edge" design was to produce a single item from many composite materials which will result in a finished product, thus reducing manufacturing costs at the final assembly. In the case of the square and round parts shown, they are escape air filter elements used in vacuum cleaners. They also serve as sound absorption pads by deadening the noise of the exhaust air.

The fused edge can be round, square or irregular in shape, and is generally flat, but can be cupped or tapered. Pressing the center or other areas gives added reinforcement.

Some industrial items to date include filters dampening and cushioning elements and battery separators.



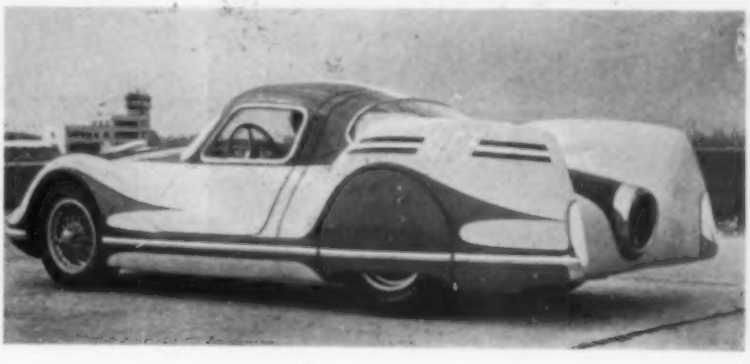
ADDITION OF SOME thermoplastic binder fibers to a wool felt fiber structure permits the bonding and molding to shape of parts like the filter units shown above.

First European Jet Car

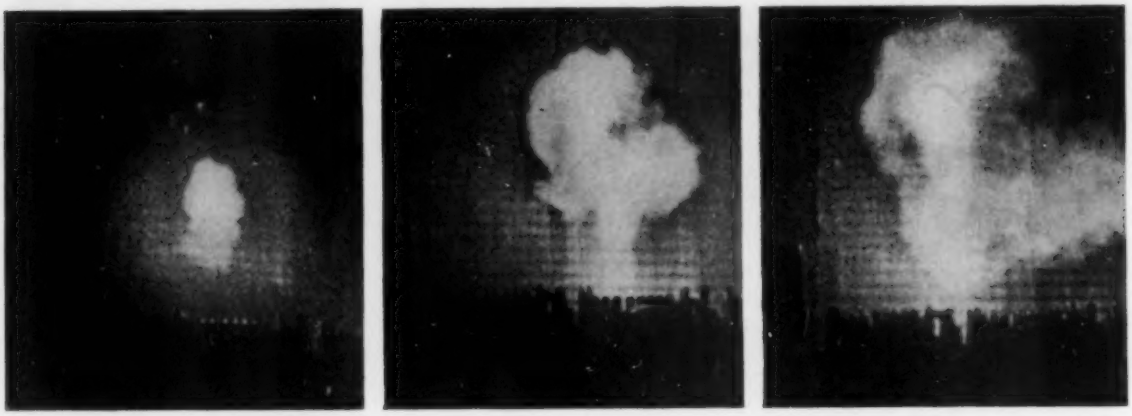
VISITORS TO the recent International Motor Show in Turin, Italy, saw the first gas turbine car to be shown in Continental Europe. Made by the Fiat Works, the turbine develops 200 hp at 22,000 rpm, giving the car a top speed of 155 miles per hour. According to Fiat, the car is strictly an experimental model, with no standard production anticipated.

The engine, located in the rear of the car, consists of a two-stage centrifugal compressor coupled to a two-stage turbine, and a driving unit consisting of single stage power turbine. The air inlet is through a single aperture in the lower front end of the car, with ducts leading to the engine. The driving unit as yet does not have a heat exchanger. Fuel consumption is presently twice that of a piston engine.

To permit easy maintenance, the entire back part of the body which covers the power plant, is removable. Weight of the car is 2200 pounds.



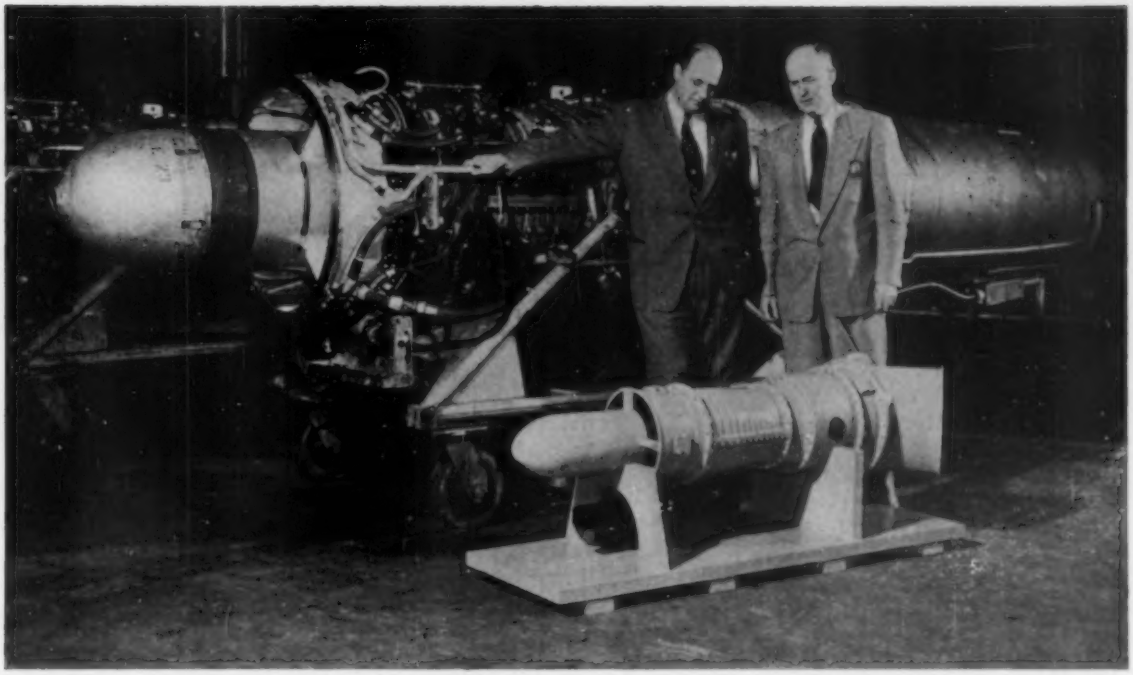
THE NEWS IN PICTURES



NOT A HYDROGEN BOMB EXPLOSION, but the start of a "flashover", that occurs in the traction motor of a diesel-electric locomotive. Because little is known about these phenomena, and as a flashover can do enough damage to put a locomotive out of service, General Electric has been conducting investigations and photographing them with high-speed motion picture camera. Those shown here were taken 1/2500th of a second apart.

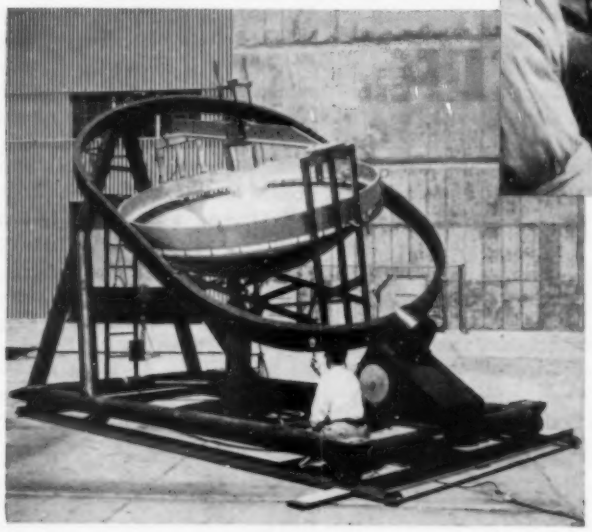
AN UNCOATED TELEVISION PICTURE TUBE is lowered into a vacuum metalizer designed by F. J. Stokes Machine Company. The flashing current is set by the rheostat at the right, one button is pushed, and a timer automatically controls all stages of the metallizing cycle. Settings are adjustable to 10 second intervals over a 10 minute cycle. Large or moderate scale production is possible.

ONE OF THE MAMMOTH BEARINGS that will go into Tube Reducing Corp's latest 18 in. tube reducer. Made at SKF, the bearings have a tapered bore, 48.0315 in O.D., are 17.2441 in wide, and have a rated capacity of 3,200,000 pounds. The giant machines will be used in a new $10¼ million project sponsored by the Navy Bureau of Aeronautics for the production of compression-formed precision tubing with O.D.'s ranging from 9 to 17 inches.



A MOCK-UP OF GE'S NEW AIRCRAFT GAS TURBINE being developed for helicopter applications is shown in front of the J47-17 jet engine used in the F-86D Sabre. The new engine is being designed primarily for helicopters, but with modifications can be adapted as a power plant for fixed-wing aircraft either as a turbo-prop or turbo-jet.

ELIMINATING THE CHANCE of human error in judging the degree of quietness, Airborne Accessories Corp. is now using an electronic "ear" to check the amount of noise in their right angle bevel gear units when run at rated speed. As noise level indicates gear condition, units are tested without lubrication so that the faintest noise can be picked up.



ANOTHER DEVICE operating on energy from the sun (see p. 190 this issue), is Consolidated Vultee's solar furnace which is being used to test materials for passage through the thermal barrier. Said to be the largest ever built, the 120 in. dia polished aluminum mirror reflects the sun's rays to a focal point 5/16 in. in dia., 34 in. from the mirror. Under ideal sky conditions the temperature at this point is 8500 F, 85 percent of the temperature of the sun's surface.

NEWS BRIEFS

EARLE BUCKINGHAM, well known author and authority in the field of gear design and research, has just been appointed Technical Director of Geartronics, the design, research and development division of The Technical Products Co., Inc. of West Concord, Massachusetts.

ILLINOIS INSTITUTE OF TECHNOLOGY has made arrangements with nineteen Midwest liberal arts colleges so that students may get a liberal and engineering education in five years. Under the new program, students completing three years of liberal studies may transfer to Illinois Tech for two years of engineering education, and be awarded two bachelor degrees, one in arts and the other in engineering at the end of the fifth year.

THE LATEST IN HIGHWAY BUS DESIGN has all four wheels suspended on rubber, and the front wheels independently sprung with no front axle. Made by the Flxible Co. with rubber springs from B. F. Goodrich, the spring consists of a metal shell and central shaft, with the space between shell and shaft filled with rubber bonded to the metals. Springing is done by the twisting, or "windup" of the rubber while the shaft or shell is held stationary, and the other is partly rotated by a torque arm.

STAINLESS STEEL ALLOYS of improved high-temperature strength have been developed for the Navy by Cornell Aeronautical Lab., Inc. Trying to replace the strategic alloys needed in jet aircraft, Cornell has uncovered three modified stainless steel alloys (basically chromium-nickel with small additions of titanium and boron) having twice the conventional strength at 1200 to 1500 F.

GENERAL ELECTRIC has developed an automatic electrical system for high performance aircraft, which they claim will eliminate a minimum of at least ten pilot functions and require no manual switching. The idea behind it all is to reduce the time required by the pilot to get the plane in the air once he climbs into the cockpit. Major components of the automatic a-c system are high efficiency alternators, static voltage regulators and generator control and protective panels.

THE DIRECTORY OF COMMERCIAL AND COLLEGE LABORATORIES, formerly compiled and published by the National Bureau of Standards, will be published in the future by the American Society for Testing Materials. The Directory contains information concerning the location of testing laboratories, together with the types of commodities and the nature of the investigations the laboratories are prepared to undertake.

DESCRIPTIONS OF 18 patents owned and held by the Atomic Energy Commission have been sent to the Patent Office for registry and listing in the official register. The Commission will grant non-exclusive, royalty-free licences on the listed patents.

New Uses of Materials Stressed

HUNDREDS OF NEW USES of materials were suggested at the various conferences as many engineers, designers, researchers, and production men gathered at the Basic Materials Conference and Exposition held at Chicago's International Amphitheatre last month. Emphasis was also placed on the development of new products, with the discussions covering not only those materials that will add to the sales value, but also materials that will help to reduce production costs. A session was devoted to advising companies how to set up a materials department.

The papers presented covered a wide field . . . ranging from the latest developments in methods of fastening and joining, and corrosion problems, to forecasts of materials that industry will be using in ten years. Stressing the latter was a paper by Carson E. Hawk, Head of the development department of the Liquid Engine Division, Aerojet-General Corporation. The title was, "Rockets and Guided Missiles . . . How New Materials For Weapons Can Help Industry."

The papers presented were as follows: "Plastics . . . How, When and Where to Use Non-Metallic Materials" by Jesse H. Day, Society of Plastic Engineers Journal; "Adhesives & Adhesive Bonding of Metals & Plastics" by George Epstein, North American Aviation, Inc.; "Carbon, Graphite . . . How, When, and Where to Use Non-Metallic Materials" by Fremont F. Ruhl, U. S. Graphite Co.; "Rubbery Materials . . . How, When and Where to Use Non-Metallic Materials" by J. H. Faull, Jr., consultant to Office of Naval Research; "New Metal Forming Processes . . . Forging, Stamping, Extruding" by J. Walter Gulliksen, Worcester Pressed Steel Co.; "How to Set Up and Operate a Materials Department" by Merritt A. Williamson, Burroughs Corp.; "New Directions in Powder Metallurgy" by Henry H. Hausner, Sylvania Electric Products, Inc.; "Glass As An Engineering Material" by W. H. McKnight, Corning Glass Works; "New Casting Techniques" by L. M. Christensen, Northrop Aircraft.

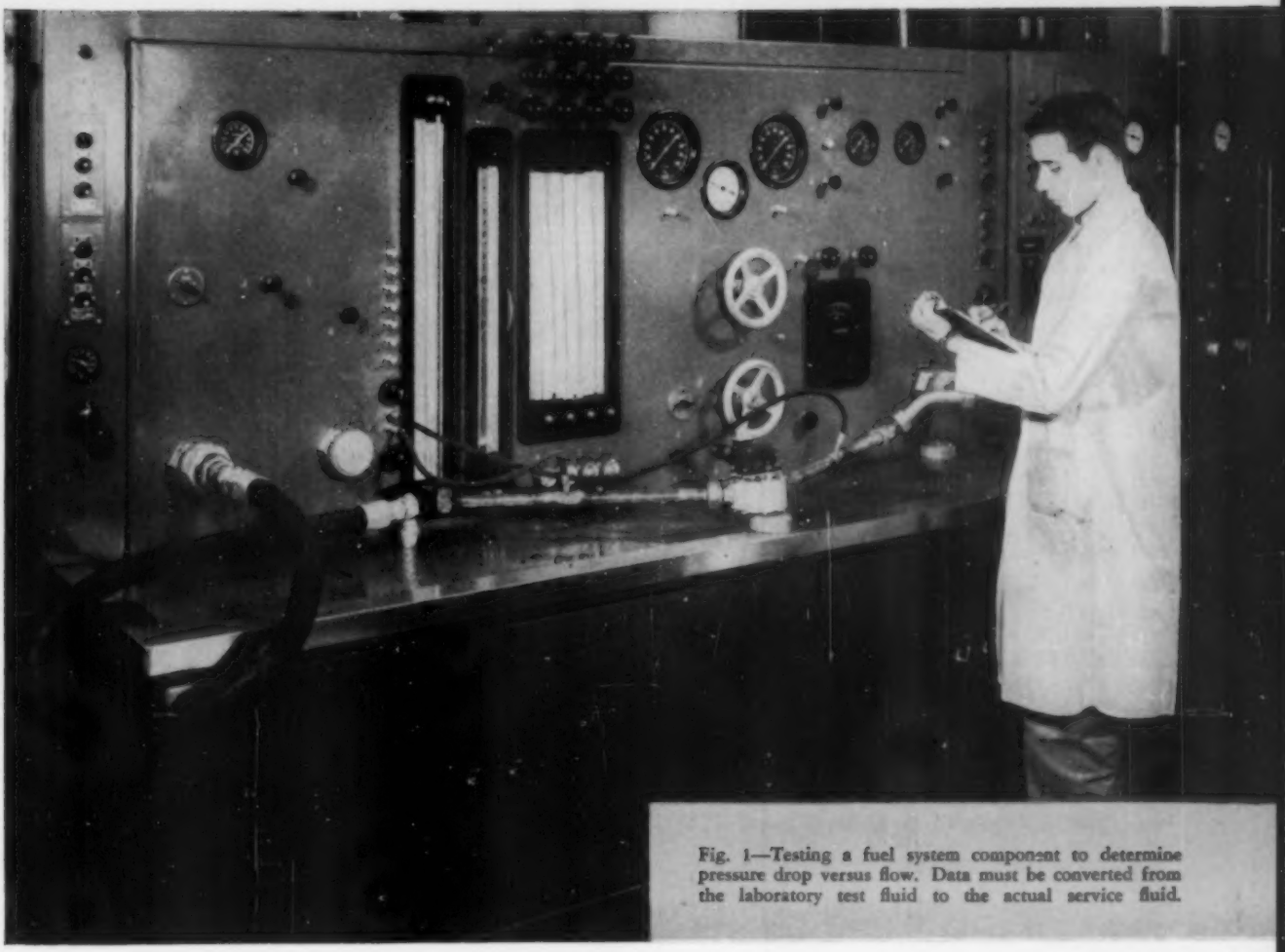


Fig. 1—Testing a fuel system component to determine pressure drop versus flow. Data must be converted from the laboratory test fluid to the actual service fluid.

Fluid Conversion Factors for Pressure Drop Calculations

ROBERT B. RESEK

Chief Development Engineer,
The Parker Appliance Company

IN DETERMINING the characteristics of hydraulic and fluid system components, data covering "pressure drop versus flow" are often required. This pressure drop determination is generally run in a laboratory, using a special test fluid of known constant characteristics that is different from the actual fluid to be used functionally in the component, Fig. 1. Under another condition, previously determined pressure drop data may be available from field tests, but these data may be for a fluid other than that required or for the same fluid at a different temperature. Therefore it becomes necessary to convert results from those obtained with the fluid used in the laboratory test, to those of the fluid to be actually in service.

The following material derives these conversion factors for three conditions: straight smooth tubing with laminar flow, straight smooth tubing with turbulent flow, and bends, fittings and valves.

Straight Smooth Tubing

The pressure drop for a length of straight smooth pipe or tubing is

$$\Delta P = \frac{L}{m} T_o \qquad (1)$$

where

$$m = \frac{A}{P}$$

and in the absolute system

L = length of tubing, feet
A = cross-sectional area, square feet
P = perimeter of cross-section, feet
T_o = the shear force at the wall per unit area, poundals per square foot.

Assume that this shear force can be expressed by

$$T_o = K m^x \rho^y \mu^z V^n \qquad (2)$$

where

k = a dimensionless number
ρ = density, pounds per cubic feet (or grams per cubic centimeter)
μ = absolute viscosity, poundal seconds per square foot (or dyne seconds per square centimeter = poises).
V = mean velocity of fluid, feet per second (or centimeters per second).

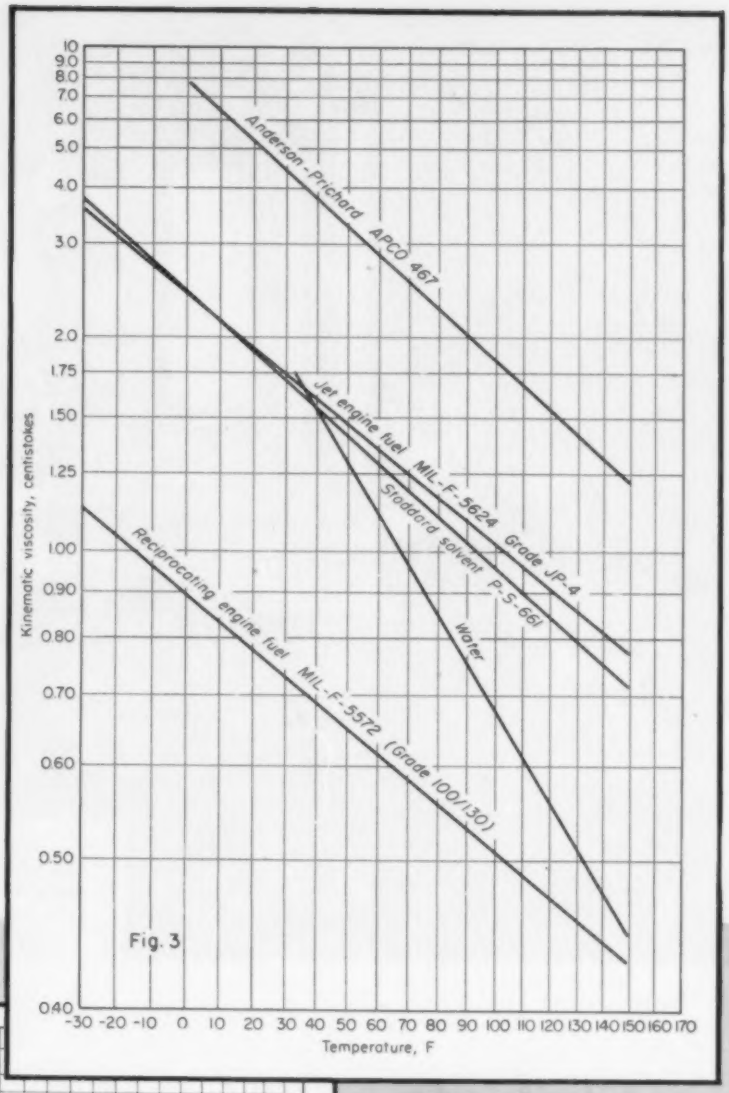
The use of the English or the metric units will merely change the factor K.

The exponents of Eq (2) can be determined by dimensional analysis in terms of n so that

$$T_o = K m^{(n-2)} \rho^{(n-1)} \mu^{(2-n)} V^n \qquad (3)$$

Laminar Flow

When the Reynolds number is less than 2,000, the flow is in the laminar



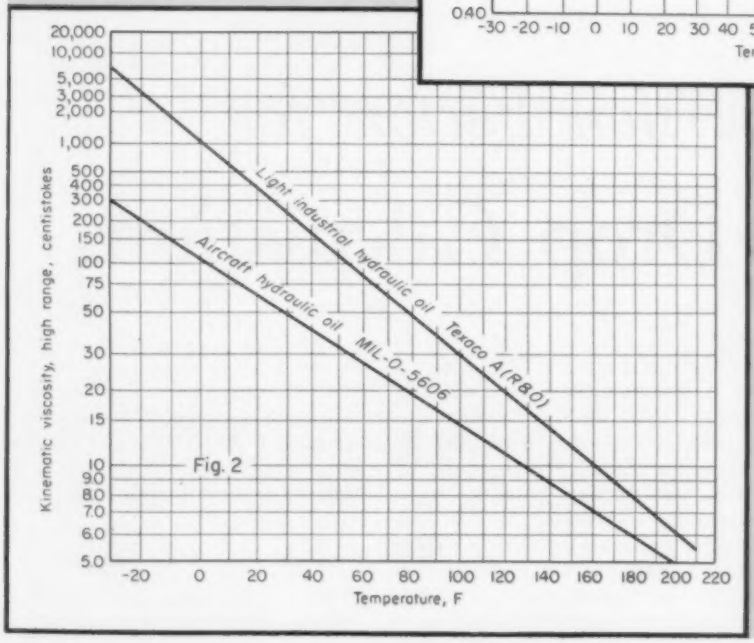


Fig. 2—ASTM standard viscosity—temperature chart for high range hydraulic oils.

Fig. 3—ASTM standard viscosity—temperature chart for low range liquid fuels and test fluids.

Fig. 4—Density as a function of temperature for fluids shown in Figs. 2 and 3.

range. The Reynolds number is equal to

$$\frac{DV\rho}{\mu}$$

where

D = tube diameter

For laminar flow the pressure drop is directly proportional to flow or n equals 1. Hence, Eq (3) becomes

$$T_o = Km^{-1}\,\mu V \qquad (4)$$

The two factors in Eq (3) relating to the properties of the fluid used are ρ and μ. Eq (4) shows that for laminar flow the shear force, and from Eq (1) the pressure drop, is independent of density, ρ, but directly proportional to the absolute viscosity μ.

Therefore, if ΔP_1 equals the pressure drop determined by test, μ equals the absolute viscosity of the test fluid, and μ_2 equals the absolute viscosity of the actual fluid to be used, then the pressure drop using the actual service fluid is

$$\Delta P_2 = \frac{\mu_2}{\mu_1}\,\Delta P_1 \qquad (5)$$

The absolute viscosity, μ, is generally given in centipoises. Often kinematic viscosity, γ, is available rather than absolute viscosity. The absolute viscosity can be determined by multiplying the kinematic viscosity in centistokes by the density in grams per cubic centimeter. Values of kinematic viscosity for several typical fluids at various temperatures are given in Figs. 2 and 3. Fig. 4 gives the density of these fluids at various temperatures.

Turbulent Flow

When the Reynolds number reaches between 2,000 and 3,000, the flow changes from laminar to turbulent. It has been shown by empirical methods that in the turbulent range the pressure drop varies as the 1.72 to 2.00 power of the velocity, the lower value being for very smooth walls and the upper value for very rough walls. For a normally smooth tube, this exponent is 1.75. Thus Eq (3) becomes

$$T_o = Km^{-0.25}\,\rho^{0.75}\,\mu^{0.25}\,V^{1.75} \qquad (6)$$

For different fluids in the turbulent range, the pressure drop varies with the density, ρ, to the 0.75 power and with absolute viscosity, μ, to the 0.25 power. Thus, if subscript 1 represents the test fluid and subscript 2 represents the service fluid, then the actual pressure drop in service is

$$\Delta P_2 = \left(\frac{\mu_2}{\mu_1}\right)^{0.25}\left(\frac{\rho_2}{\rho_1}\right)^{0.75}\Delta P_1 \qquad (7)$$

Bends, Fittings and Valves

The equations given above apply to pressure drops through straight tubing where the losses are caused by the frictional resistance of the walls and thus depend on the fluid viscosity. Other losses in a fluid system are caused by the change in magnitudes or direction of the velocity resulting from enlargements or contractions of the passage cross-section or bends, and changes in direction in tube fittings, valves or other components.

In a thin sharp orifice the loss is entirely caused by inertia forces and is completely independent of friction forces such as the fluid viscosity. In a fitting or valve, the frictional losses from the short length traveled through the component are generally so small, compared to the losses from inertia effects, that viscosity is ignored. Thus, the pressure drop in pounds per square foot is proportional to the density and the square of the velocity.

$$\Delta P = K\rho\frac{V^2}{2g} \qquad (8)$$

where g = acceleration of gravity, feet per second per second.

The converted pressure drop is

$$\Delta P_2 = \frac{\rho_2}{\rho_1}\,\Delta P_1 \qquad (9)$$

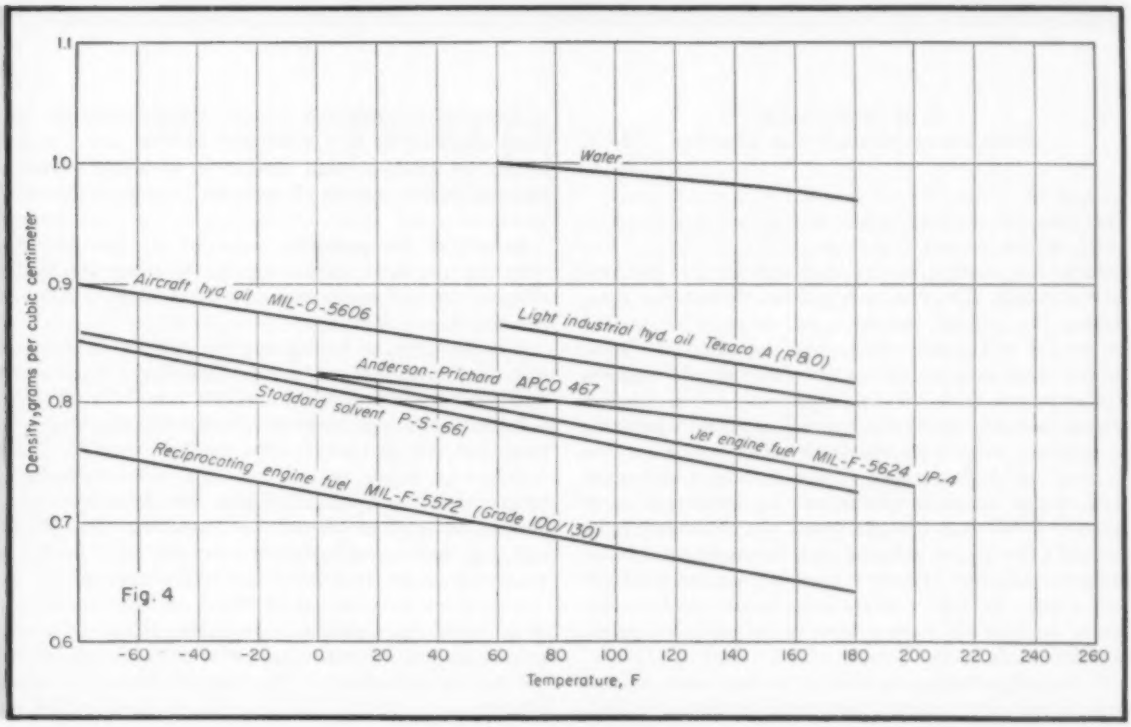


Fig. 4

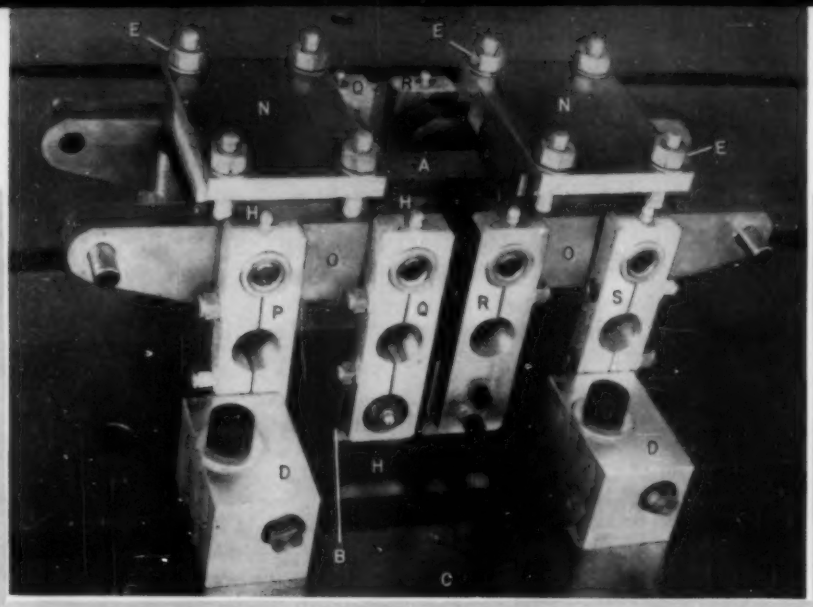


Fig. 1—Standard type materials testing fixture designed for bending fatigue tests on 1,000 lb universal machine. Fixture will handle wide range of specimen size and material by varying arrangement of pivot arms and beams.

Fatigue Testing Fixtures

For Materials Testing and Simulated Service Testing
Types . . . Design Information . . . Applications

T. R. BREUNICH
Project Engineer, Sonntag Scientific Corporation

FIXTURES for holding fatigue test specimens can be divided into two classes in accordance with the type of test: fixtures for material testing and fixtures for simulated service testing. The first class will handle tests for determining the physical properties of materials, comparison of welded and brazed joints, and the effect of various surface conditions on the fatigue limit of the material. This type test deals only with materials and is not concerned with the use of the material in actual equipment. In contracts, fixtures for simulated service testing are used in tests that duplicate field or service failures and conditions so that design and manufacturing techniques can be studied. While such testing requires some laboratory facilities and a few trained technical men, the results obtained are often the difference between a successful and an unsuccessful design. In many instances, a single standard type testing machine and a few fixtures can be used for a variety of different tests.

Many fatigue testing machines can be purchased complete with fixtures for testing material (Table I) in tension-compression, bending and torsion. These fixtures are specially designed to fit a particular machine and are able to use the machine's full capacity to advantage. Usually they will handle tests on all materials from plastics to alloy steels.

Because of the specialized nature of the operation, fixtures for simulated service testing are either specifically designed for one application or adapted from a standard materials testing fixture.

The flexibility of testing and the number of different types of fixtures that can be used depend to a large extent on the testing machine that is available (see Fatigue Testing —Its Machines and Methods, *Product Engineering*, February and March, 1953). For example, rotating beam machines are single purpose units only usable for bending fatigue tests. These will only handle cylindrical specimens, limiting the type of fixture to a standard model. While universal machines will perform either class of test and can use a wide variety of standard and special fixtures.

To achieve the necessary flexibility, such factors as machine limits, the mechanical properties of the materials, and the construction and capacity of the fixture itself (Table II) must be considered in the design of materials testing fixtures.

TABLE I—TEST SPECIMEN DESIGN

1. A smooth large radius fillet must be used between test section and grip ends. Fillet polishing should run parallel to the axis of the piece rather than circumferentially. Too short a radius or tool marks in the radius can result in stress concentration and failure at that point.

2. Ratio of grip area to test section area should not be less than 3 or 4 to 1, or failure may occur in grips instead of in test area.

3. Radial polishing or tool marks in the test area usually cause premature failure.

4. Surface heating and resultant surface tension caused by machine polishing can reduce the fatigue limit.

TABLE II—HINTS IN DESIGNING FIXTURES FOR DYNAMIC TESTS.

1. Avoid bearings wherever possible by using flexplates. If bearings are required, use anti-friction types allowing a liberal safety factor. Design bearing mount so that bearings are easily removable and can be clamped to reduce clearance.

2. Keep all bolts as long as possible to obtain maximum strain energy storage. This method is superior to the use of lockwashers for keeping bolts from loosening under the testing load.

3. Preload or clamp all joints with a force greater than the dynamic force they must transmit. Any joint, and particularly threads, will fret and rattle if not properly clamped. This will cause corrosion or induce higher harmonics. Corrosion results in part failure, while harmonics distort the force wave to the extent that the peaks are higher than those of a pure sine wave. Press fits are good where applicable. If welds are used they must be thoroughly annealed or the residual stress can cause failure.

4. Use light-weight materials for all vibrating parts but protect clamping surfaces with thin hardened steel. The steel inserts should be easily renewable.

5. Use liberal fillets at all high-stress points and, if necessary, treat surfaces to raise the endurance limit. Shotpeening often allows the use of mild steel in place of heat-treated alloy steels. This simplifies manufacture and reduces warpage and residual stresses.

6. Be sure fixture applies proper force and that service simulating fixtures actually duplicate field conditions.

Materials Testing Fixtures

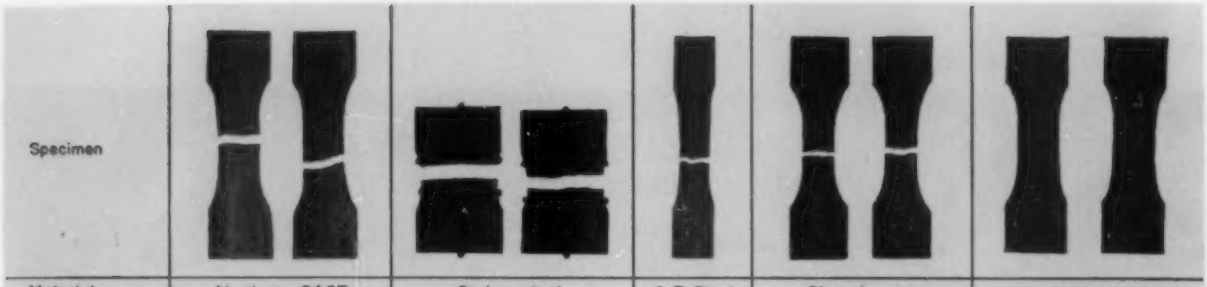
Every machine has maximum and minimum force limits and maximum stroke or amplitude limits. These determine in general the type and size of fixture that can be used. Of equal importance are the mechanical properties of the material being tested. For example, plastics have a low modulus and usually a low stress while the ferrous material have a high modulus and stress. In between these are the various nonferrous metals. Thus, a fixture must have provision for giving a low force-high stroke condition for testing plastics and a low stroke-high force for the ferrous alloys, with intermediate steps for testing materials with properties between these two extremes.

In addition to the necessity of having it fit both the machine and material, the fixture must also be strong enough to resist damage and failure from vibrating forces during the test, and it must be as light as possible, since its weight imposes an additional load on the machine. Fig. 1 shows a material testing fixture designed for bending tests on a 1,000 lb universal machine. It incorporates many of the features noted above and will handle a wide range of materials.

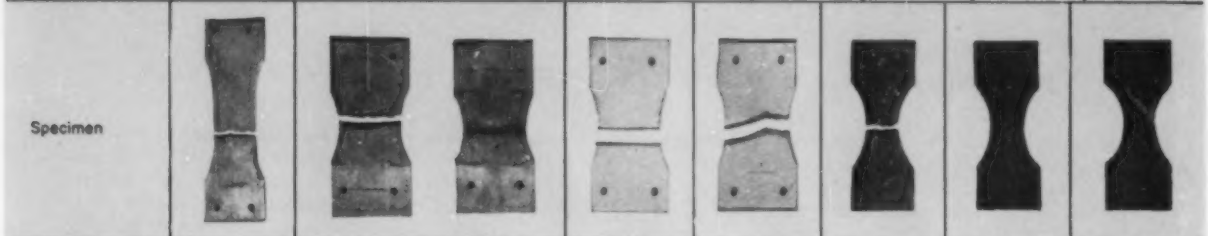
The specimen, *A*, is clamped to the fixture by the holding plates, *N*. Pivot arms *Q* and *R* are fastened to the vibrating platen, *F*, while pivot arms *P* and *S* are fastened to the fixed bed by means of blocks, *D*. Vibration of the platen exerts a reversing bending force on the test specimen.

Fixture stiffness is obtained by using deep-sectioned beams, *O*, and stiff pivot arms, *P*, *Q*, *R* and *S*. The use of the long clamping bolts, *E*, increases the total bolt strain and prevents the nuts from loosening in service. Oversize anti-friction bearings used in the split-pivot arms are clamped to eliminate clearance between the outer race and the arm, and also so that they can be easily replaced when worn. For lightness, all structural arms are either magnesium or aluminum. The clamping surfaces (bottom of plates, *N*, and top of webs connecting beams, *O*) are lined with hardened steel plates to reduce the wear and fretting as the specimen works under load. These liners can also be replaced when worn.

To accommodate various materials and specimen lengths, the component parts of the fixture can be rearranged. As shown, the shortest specimen and lever arm are being used.



Specimen									
Material	Aluminum 24ST		Spring steel		C. R. Steel	Phos. bronze		Copper	
Thickness	0.125 in.	0.125 in.	0.032 in.	0.032 in.	0.125 in.	0.082 in.	0.082 in.	0.125 in.	0.125 in.
Width	1.0 in.	1.0 in.	1.75 in.	1.75 in.	0.74 in.	0.75 in.	0.75 in.	1.0 in.	1.0 in.
Stress	±30,000 psi	±26,000 psi	±135,000 psi	±109,000 psi	±54,000 psi	±55,000 psi	±50,000 psi	±30,000 psi	±22,500 psi
Cycles to failure	139,000	246,000	16,200	64,000	289,000	152,000	248,000	15,000	110,000



Specimen								
Material	Brass	Lead (SJ)	Lead (TXXX)	Lucite	Cellulose acetate	Textolite	Panelyte	Plywood
Thickness	0.094	0.146	0.149	0.127	0.25	0.26	0.243	0.255
Width	1.0 in.	1.47 in.	1.47 in.	1.50 in.	1.50 in.	0.75 in.	0.75 in.	0.75 in.
Stress	±30,000 psi	±1,750 psi	±2,000 psi	±3,100 psi	±1,800 psi	±5,600 psi	±7,600 psi	±5,160 psi
Cycles to failure	851,000	221,000	110,000	22,500	145,000	1,914,000	34,000	121,000

Fig. 2—Range of materials that can be tested on universal bending fixture shown in Fig. 1. Various shapes and sizes can be tested without exceeding machine capacity in either required force or amplitude of motion.

By moving pivot arms *P* and *S* out to the end pins of beam *O*, a longer lever or larger couple can be obtained. By moving the two halves apart or reversing the two beams, longer specimen lengths can be used. Thus, by using the proper combination of lever arm and specimen length, practically any material can be tested and still stay within machine limits of force and amplitude.

In Fig. 2 are shown some of the diverse materials that can be handled by this fixture. The width and length of the specimens demonstrate how the fixture was used to obtain the required stress without exceeding the machine limits. The higher modulus material specimens are longer and usually narrower than the lower modulus ones. This allows higher stress without excessive amplitude on the high modulus materials, while the short specimens give greater strain on the low modulus materials where lower stresses are satisfactory.

These fixtures are supplied with charts showing the available strain range for various specimen shapes and widths, combined with the different fixture arrangements After the stress range has been selected, the fixture setting and specimen dimensions can be obtained from these charts.

A universal torsion fixture is shown in Fig. 3. The specimen is gripped in collets, which are available in various diameters. Lever arm length can also be varied. This allows greater strain for a given stroke but reduces the total force. As in the bending fixture, the unit is heavily built and the parts that are subject to wear, such as the collets and bearings, can be easily replaced.

A major problem in the design of small motion fixtures is the bearings. This is particularly true with bending and torsion fixtures. No bearing will stand up under oscillating loads where the motion is less than the circumference of one ball or roller. This action causes brinnelling with resultant binding and corrosion of the bearing. This can be overcome by using a factor of safety of 600 percent or more; however, on large units the bearing size becomes objectionable. The high capacity torsion fixture of Fig. 4 uses two methods to overcome this difficulty.

A flexible plate, *A*, is used to transmit the machine force from the vibrating platen, *B*, to the torsion arm, *C*. This plate bends through an arc as the arm oscillates. The thin sections of the plate reduce the bending stresses below the endurance limit so that the member does not fail during service. This feature reduces the required number of pivot bearings by at least two.

Pivot bearings must be used on the shaft end of the torsion arm, *C*, and so some other method must be used to prevent the undesirable fretting action common to antifriction bearings under these conditions. This is accomplished by rotating the inner shaft of the bearing continuously by means of the gear motor, *D*, so that, although the oscillating action is present, new shaft surfaces, rollers and lubricants are constantly being presented to carry the load.

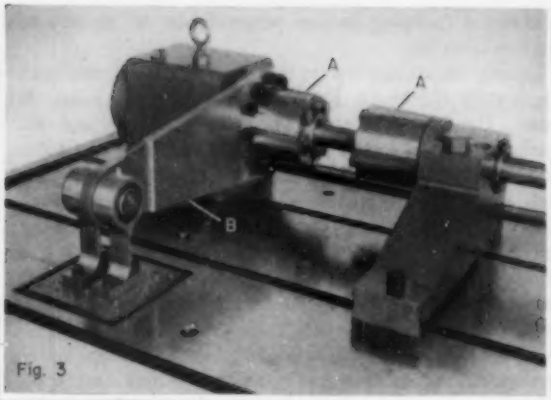


Fig. 3

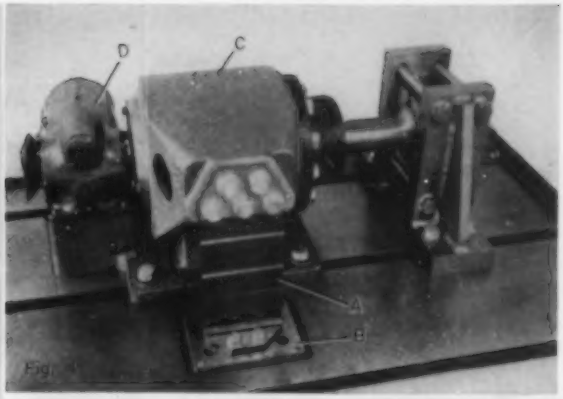


Fig. 3—Universal torsion testing fixture. Collets, *A*, and lever arm, *B*, can be changed to handle various diameter specimens at various amplitudes of motion.

Fig. 4—Heavy duty torsion testing fixture. Unique feature is gear motor, *D*, which rotates inner shaft of lever arm bearings. This prevents premature failure of anti-friction bearings which normally occurs under low-amplitudes oscillating loads.

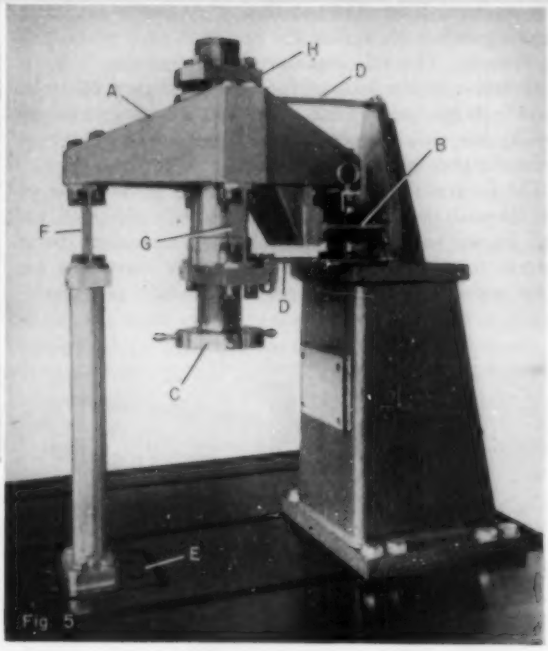


Fig. 5

Fig. 5—Two-to-one multiplying fixture for tension-compression fatigue testing. Specimen length can vary between 14 and 20 in. On a typical 10,000 lb machine, this fixture makes available a force of 20,000 lb at a maximum amplitude of $\frac{1}{4}$ inch.

This allows a bearing of normal rating to be used without loss of reliability and with a considerable saving in size.

The testing of materials in tension-compression requires high forces to achieve stresses above the endurance limit. Since there are no levers or mechanical-advantage devices required for this type of test, the machine must supply the whole force directly or some device must be added to increase machine force. This is in contrast to bending and torsion tests which require levers to apply the necessary moment. Rather than penalize the bending and torsion tests by using an oversize machine that will supply the tension-compression force directly, a fixture with a mechanical advantage, Fig. 5, is used to give the same result. This particular fixture increases the force capacity by two and cuts the stroke in half, saving on the size and cost of the extra capacity in the machine itself. The reduction in stroke is usually not important, since tension-compression specimens are rigid and have low deflection rates.

The fixture has several characteristic design features. Oscillating parts, not subjected to wear, are made of aluminum. Screws are made as long as possible to obtain a large elastic deformation and prevent loosening under vibration. No sliding bearings are used in the pivot system. The lever, *A*, pivots on crossed flexplates, *B*. These are rigid horizontally and vertically but offer little resistance to rotation. The work platen, *C*, is guided from the vertical post by flexplates, *D*. Force is transmitted from the vibrating platen, *E*, through flexplate, *F*, and from the lever to the work platen by flexplates, *G*.

Another important point is the locking of the threads that regulate the height of the working platen. The force exerted on the threads by the clamping ring, *H*, must be at least equal to the machine force if hammering and fretting are to be prevented. On high frequency machines, this force must be well in excess of the machine force or distortion will occur because of second harmonics.

When testing rigid tension-compression specimens, any unequal tightening of the clamping members or misalignment of the threads will induce in the specimen a bending stress that often exceeds the test stress. The high temperature test fixture shown in Fig. 6 is designed to prevent bending stresses. The bottom clamp of this fixture rigidly holds the specimen while the top clamp uses pairs of wedges

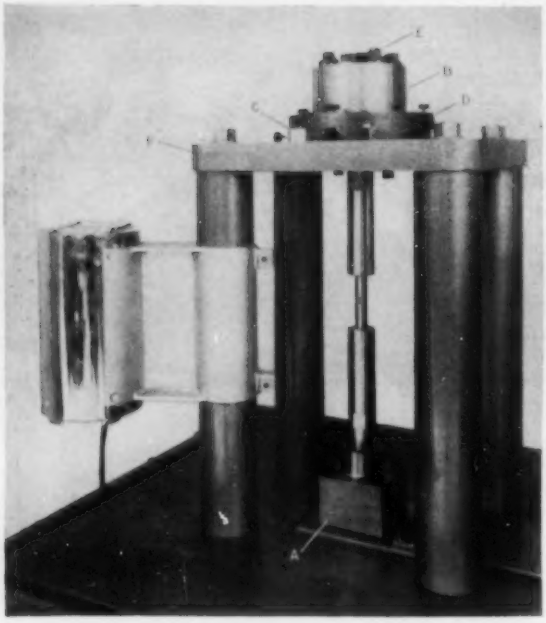


Fig. 6—High-temperature tension-compression fatigue testing fixture. Adjustable top clamp permits accurate specimen alignment. This prevents unwanted bending stresses in rigid specimens, always a problem in this type of test, and particularly so under high-temperature conditions.

to obtain a clamping surface perpendicular to the axis of the extension bar.

During set up, the system is approximately aligned with the bottom clamp, *A*, tightened and the top clamp, *B*, loose. The heater unit is swung into position, and the specimen brought to test temperature. The pairs of double wedges, *C*, are then adjusted so that they just make contact with the clamping surface ring, *D*. The top clamping screws, *E*, are tightened, locking the extension bar threads and securing the top clamp to the stationary platen, *F*. This arrangement allows the top clamp to move freely during heating and then gives a firm aligned base for top clamping.

This fixture also preloads thread-ended specimens to prevent rattling and harmonics during reversed stress tests. The specimen screws into the hollow extension bars. Inside these bars are clamping rods, spring loaded through Belville washers. When the end clamps are drawn out, these clamping rods push against the specimen ends preloading the threads. The full pressure of the clamping bolts is used, and a higher locking force obtained than could be possible using clamping nuts. Locknuts will prevent thread rattling but they do not preload the threads enough to prevent higher harmonic distortion.

The fixtures shown in Figs. 1 through 6 have been of the materials testing class and are usually designed for well known conditions. The following discussion covers fixtures for simulated service tests where conditions are often not known and the cause of failure determined.

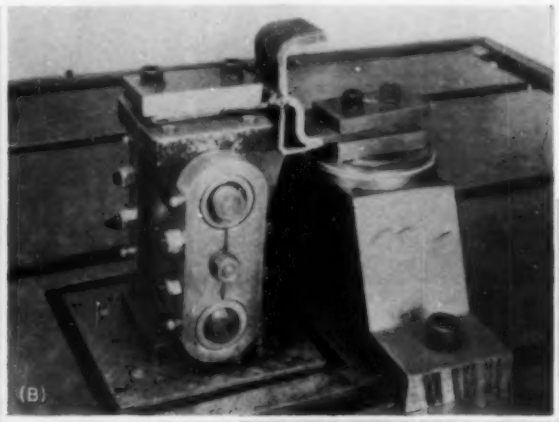


Fig. 7—(A) Simulated service fatigue testing fixture used for determining the bending fatigue limit of a brazed loom part. Care must be taken to duplicate field service conditions. (B) Shows another brazed assembly being tested in same fixture. Well designed fixture parts can often be used in a variety of tests.

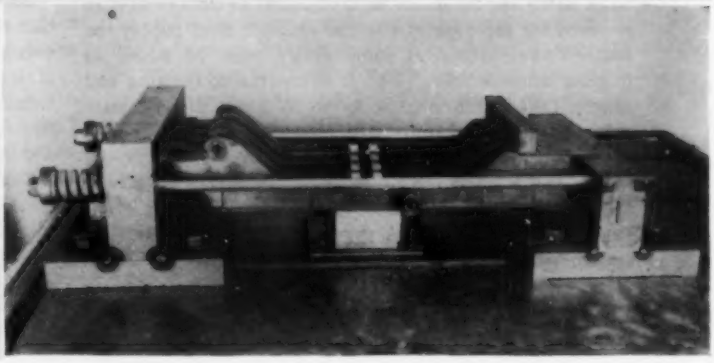


Fig. 8—Special fixture for testing complex assembly in bending. This demonstrates general rule that stationary clamps should be heavy and rigid, while moving clamp should be as light as possible to reduce inertia forces.

Simulated Service Testing Fixtures

The details and requirements of this type test are determined by a specific problem; however, the general requirements of the fixtures used are similar to those of the universal types. Since the applied force is a dynamic one, particular attention should be paid to the inertia forces.

Inertia forces vary as the square of the frequency and as the first power of the amplitude of motion. The machine or fixture must be designed to compensate for these forces or a correction factor used. Without these precautions, inertia forces can often exceed the applied force. This results in a force in the specimen that is both unknown and variable and leads to incorrect test results.

In Fig. 7(A) is shown a fixture used for determining the best method of brazing or joining on a weaving loom part. The part shown is brazed at the point of flexure. The service conditions to be simulated were such that standard fixture parts could be adopted for use on the oscillating end. Note the oversize bearings and the method of clamping. Fig. 7(B) shows another part also being tested for the best method of brazing. The same fixture is used. This is often possible when the basic fixture parts are designed for flexibility.

A more complex setup is shown in Fig. 8. This arrangement also tests various assembly methods. The fixture, method of applying the force, and size and amplitude of motion of the force must be carefully selected to duplicate actual machine loading.

In many tests, the duplication of field conditions is not as simple as shown in Figs. 7 and 8, and preliminary experimental work is necessary before designing the fixture. For example, a test was run on a connecting rod where field failures were occurring at a point about 20 percent of the length from the bearing end. The initial fixture was designed to apply tension-compression. This type of loading caused failure to occur in the bearing, showing that service conditions had not been duplicated. Further analysis led to the fact that side inertia forces were causing bending fatigue failures. The fixture was redesigned to produce the proper bending forces and test failures similar to field failures resulted. Tests could then be run to determine the best method of strengthening the section to prevent failure.

Similar problems were encountered in the ambient temperature turbine blade test shown in Fig. 9. Since the blade is not symmetrical, the exact plane of flexure was not obvious. The clamping angles shown were approximately determined by static deflection tests and then modified when dynamic tests were run.

In Fig. 10 is shown a standard fixture combined with a special bearing arrangement for testing a wheel spindle in torsion. Here too, field loadings are duplicated to determine weak points and aid in designing a stronger assembly.

While complicated assemblies may require expensive fixtures, most every-day problems of the type shown here can be solved by using adaptations of standard fixtures or simple special units. At a relatively low cost, individual part weaknesses can be determined and corrected without using or endangering the expensive overall assemblies in which they are used. In addition, test results can be accelerated so that the weaknesses can be corrected before costly field failures occur. Under any condition, the time taken to lay out and design a good fixture is time well spent.

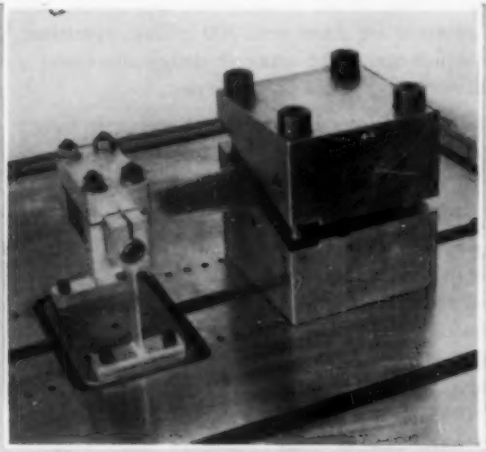


Fig. 9—Special setup for testing turbine blades in flexure. This is typical of type of test where experimental static tests must be run before proper method of fatigue loading can be determined. Fixture is constructed of standard and special parts.

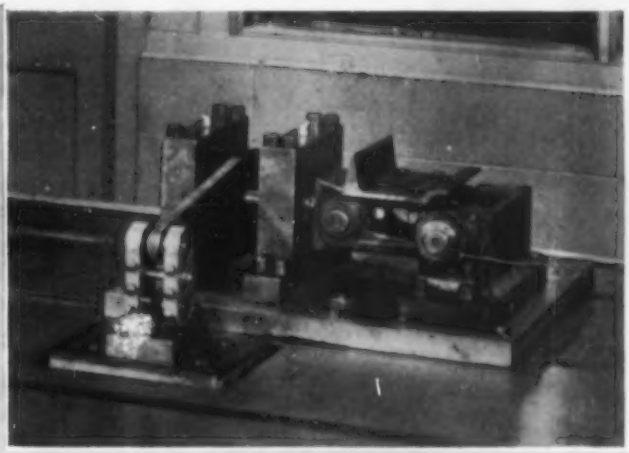
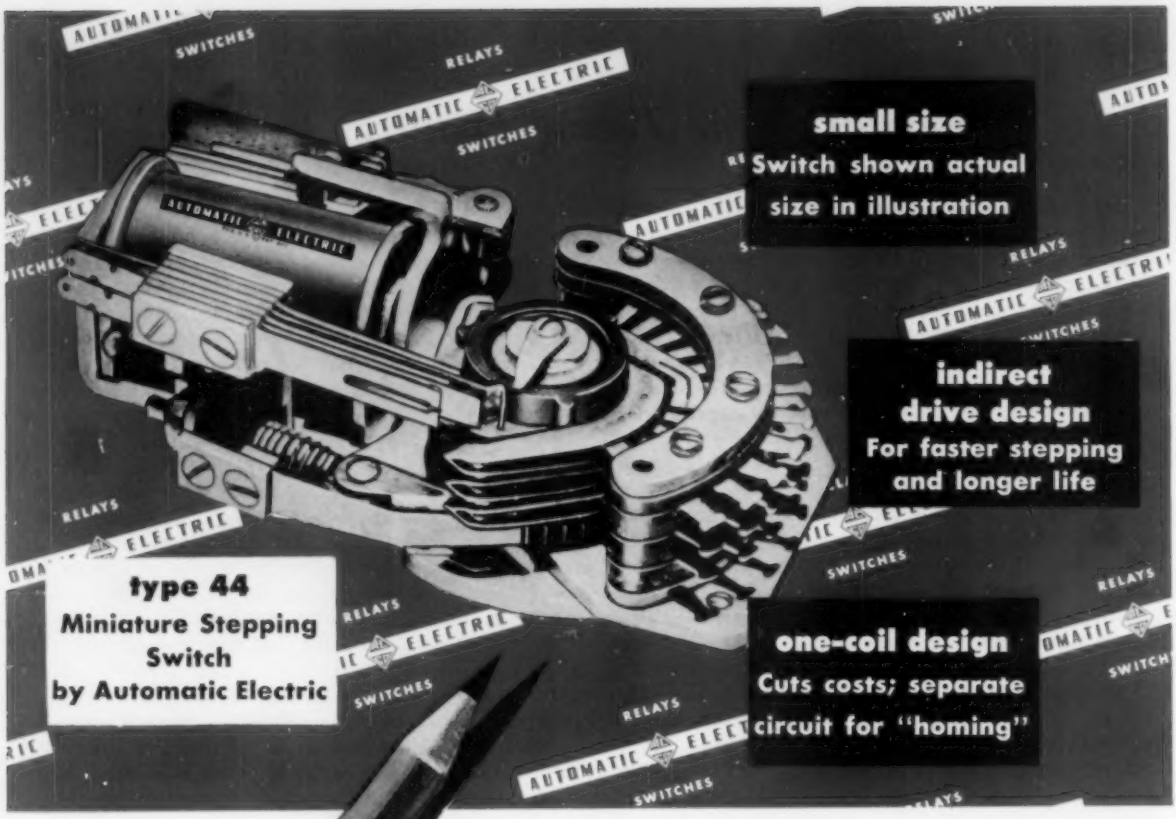
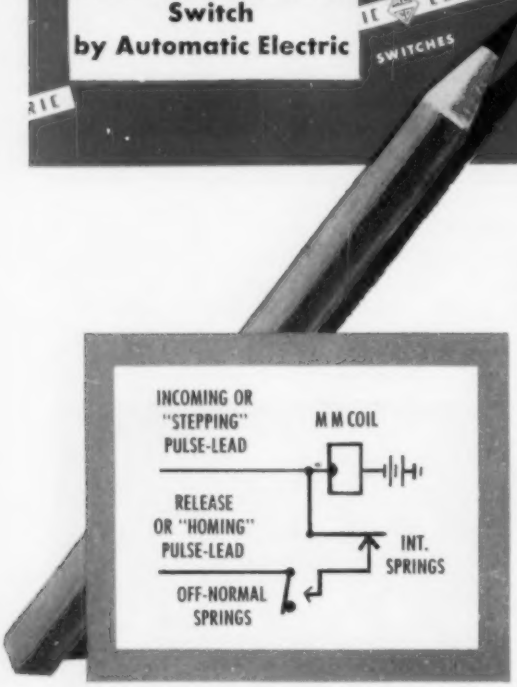


Fig. 10—Test setup for simulating the torsional loading on a wheel spindle. Note use of rigid pivot arms with oversize anti-friction bearings. These arms are standard and can be used in constructing many special arrangements. Machine duplicates field loadings that aid in designing stronger assemblies.





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Strength of Cast Alloys at 1,200 F

JOSEPH R. LANE
Naval Research Laboratory

MOST ALLOYS are used in the forged condition. However, a casting is employed when the alloy is unmachinable, or when an intricate shape is required. For high temperature service, the poor machinability of the alloy frequently decrees the use of a casting, such as vitallium castings for gas turbine blades.

Even where a forgeable alloy can be specified, if the shape of the part is intricate it might be more economical to avoid excessive machining by using a casting. Information on mechanical properties of alloys in the rolled condition is commonly available. However, data for the same alloys in the cast condition, are quite limited. The difference in microstructure between the cast and the forged condition results in large differences in mechanical properties.

With the support of the Bureau of Ships, the Naval Research Laboratory cast and tested a group of alloys which are in common use in the rolled condition. Since only a single heat of each composition is represented by these test data, further work is required to obtain precise design information.

The alloys selected, and their compositions, are shown in Table I. The room-temperature mechanical properties of these alloys are listed in Table II. Specimens measuring ¼ in. x 1¼ in. were machined from the 70 lb. ingots, and tested in stress-rupture at 1200 deg. F. From these tests the rupture stresses which would give lives of 100 and 1000 hours were determined. These data are shown in Table III. By being subjected to the 1200 deg. F temperature for 16 hours before the load is applied, the stress-rupture specimens in effect received a 1200 deg. F aging treatment before the test. The tensile specimens did not receive this prior treatment.

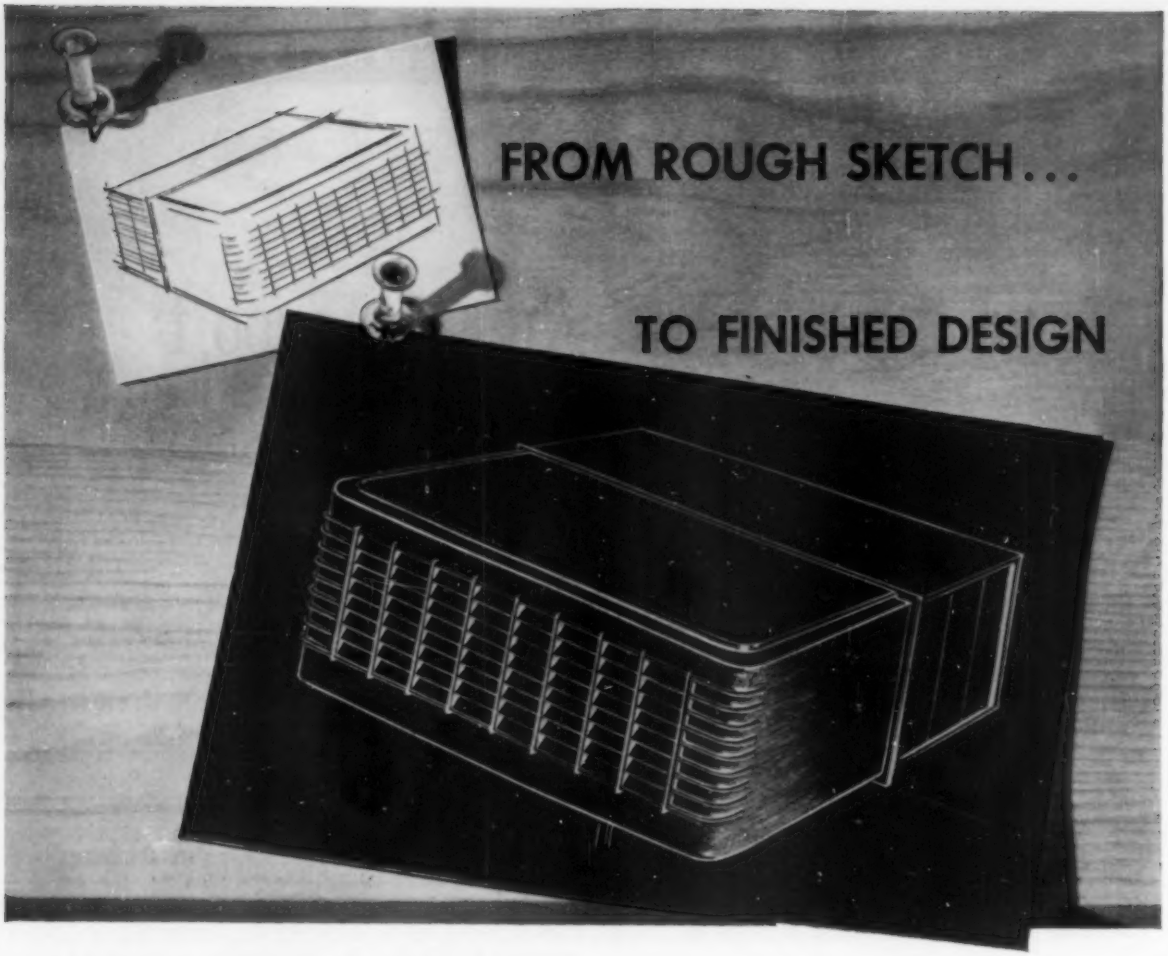
For purposes of comparison, the properties of commercial

The data presented in this article are those of the authors and are not to be construed as official data released by the Naval Research Laboratory.

Table I—Composition of Selected Cast Alloys

Name	C	Mo	Ni	Cr	W	Cb	Mn	Si	Other	Fe
15-25 Mo	0.09	6.0	24.4	16.1	....	....	1.82	0.62	0.06N	Bal.
13-19W	0.40	0.40	19.2	12.6	2.65	....	0.70	0.69	.....	"
18-8 Mo	0.23	0.92	9.2	18.6	1.38	0.28	0.58	....	0.25 Ti	"
18-8 W	0.05	0.36	9.0	19.3	1.52	0.29	....	0.34	0.26 Ti	"
15-25 Ti V	0.05	1.18	23.4	14.2	....	....	....	....	1.96 Ti, 0.42 Al, 0.24 V	"
18-5 Mn Cb	0.52	1.36	5.0	19.0	1.63	0.70	3.85	....	.....	"
18-5 Mn W	0.49	1.40	4.9	18.6	1.49	0.44	4.40	0.22	.....	"
18-5 Mn W Mo	0.41	2.4	4.7	17.8	1.74	0.29	4.05	0.16	.....	"
23-3 Mn	1.00	....	2.7	22.9	....	....	12.0	0.54	.....	"
18-5 Mn Mo	0.69	2.5	4.2	17.7	....	....	4.6	0.51	.....	"
15-25 Ti Al	0.07	3.0	24.7	14.2	....	....	....	....	1.88 Ti, 0.35 Al	"
16-15 Mo Cu	0.11	2.93	14.9	16.2	....	0.62	1.05	0.20	0.09 Ti, 2.7 Cu	"
12 Cb	0.15	0.49	....	11.3	....	....	0.49	0.08	0.70 V, 0.14 Cb	"
12 V	0.16	0.55	....	11.5	....	....	0.50	0.18	0.68 V	"
12 Mo	0.17	1.01	....	11.3	....	....	0.49	0.15	0.69 V	"
Ni Mo	0.07	29.2	64.6	....	....	....	....	0.08	.....	6.0
18-8 W Ti	0.09	....	9.1	17.5	1.07	....	0.50	0.49	1.36 Ti	Bal.

(continued on page 209)



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alloys of similar compositions in the wrought state are compiled in Table IV. Data are available for these alloys in various conditions, such as cold-worked, or annealed. The values for each alloy listed in the table corresponds to the treatment which produced the best properties. Only a single heat-treatment was given the cast alloys and it is possible that alternative treatments would result in improved properties over those shown in Tables II and III.

The properties of a specimen are influenced by the conditions under which it is cast. For the alloys shown, the long direction of the specimens was parallel to the long direction of the ingots. A special group of specimens (of Ni-Mo alloy) was prepared, cut in a direction crosswise to the axis of the ingot. A heat of the same alloy was split, and cast half in sand and half in a metal mold. The four groups of specimens, influenced by cooling rate and by solidification direction, were then tested in stress-rupture. The results showed very little difference in the rupture life or the percent elongation at rupture, only the relatively small amount of scatter that is usually obtained in rupture testing was detected.

These results were obtained through the work of Paul Shahinian, Henry E. Frankel, Joseph Atwell, and William O. Baker.

Table II—Room Temperature Tensile Properties of Cast Alloys

(2.25" x 0.357" Specimens)

Alloy	Condition	0.2 Percent Y. S., psi	Max. T. S., psi	Percent Elong.	Percent R. A.
15-25Mo	As-Cast	33,500	77,500	46	49
	Heat-treated	34,000	82,000	30 to 46	31 to 40
	Heat-treated, tempered	42,000	84,200	40	59
13-19W	As-Cast	44,300	69,500	3 to 35	2 to 32
	Heat-treated	40,000	72,000	2 to 30	4 to 35
18-8Mo	As-Cast	33,500	84,000	44	37
	Heat-treated	34,500	83,500	45	39
18-8W	As-Cast	32,800	75,300	15	24
	Heat-treated	34,600	82,400	64	71
15-25TiV	Heat-treated	76,300	102,600	11	12
18-5MnCb	As-Cast	54,000	92,500	11	9
	Heat-treated	60,000	92,500	13	13
18-5MnW	As-Cast	52,000	99,000	20	18
	Heat-treated	52,000	97,000	8	9
18-5MnWMo	As-Cast	51,500	100,000	15	16
	Heat-treated	49,000	109,000	21	8
23-3Mn	As-Cast	62,000	91,500	3	8
	Heat-treated	60,300	99,000	1	2
18-5MnMo	As-Cast	63,000	94,000	7	6
	Heat-treated	62,000	92,500	4	5
15-25TiAl	Heat-treated	73,000	98,500	10	10
16-15MoCu	As-Cast	47,000	64,000	14	12
	Heat-treated	28,100	62,600	27	42
12Cb	Heat-treated	95,000	110,000	1.4	3.5
12V	Heat-treated	.....	132,000	1.4	5.0
12Mo	Heat-treated	.....	116,000	1.4	2.3
NiMo	As-Cast	46,800	63,300	10	12
	Heat-treated	51,750	104,700	35	28
18-8WTi	As-Cast	44,000	75,200	12	8
	Heat-treated	41,000	69,500	10	17

Heat treated: **13-19W, 18-8Mo, 23-3Mn, 18-5MnMo, 16-15MoCu, 12Cb, 12V, 12Mo, NiMo, 18-8WTi; 2,100 F, ½ hr., air cooled.**
15-25Mo, 18-8W, 18-5MnCb, 18-5MnW, 18-5MnWMo: 2,100 F, ½ hr., water quenched.
15-25TiAl; 1,800 F, 1 hr., 1,250 F to 1,400 F, 5 hr., cooled to 1,200 F held 20 hr., air cooled.
15-25TiV; 1,800 F 1 hr., oil quench; 1,325 F for 16 hr., air cooled.

(continued on page 211)

Armco ZINCGRIP Tubing is used for the pump barrel of a garden sprayer. The air-compressing piston works against the smooth interior of the tube; the exterior is exposed to spray chemicals.

AT LAST...welded steel tubing that's ZINC COATED

Have you avoided using welded steel tubing in your products because you couldn't get the rust protection of a zinc coating? You can now obtain Armco Tubing made of ZINCGRIP, the steel coated on both sides in a bath of molten zinc by a patented process.

This special zinc coating doesn't peel or flake when severely formed or drawn. It gives the steel *complete* protection—your tubular products lasting beauty.

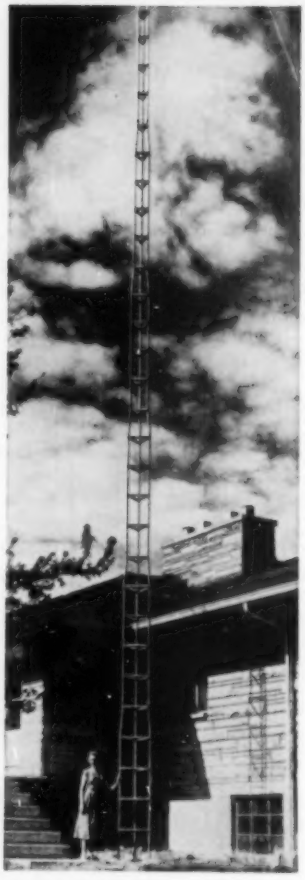
EVEN WELD IS COATED

There's no welding flash on the outside of the tube. It's planed away and a new zinc coating is applied by a special metalizing process. The location of the welded and recoated seam can be found only by careful inspection—it's that smooth!

WORKS LIKE COLD-ROLLED TUBING

Because of the high ductility of the steel base and the remarkable adherence of the zinc coating, you can cold-work Armco ZINCGRIP Tubing to practically the same extent as cold-rolled tubing. Moreover, it is supplied in many special shapes.

For further information on Armco ZINCGRIP Tubing fill in and mail the coupon. If you are interested in uncoated welded tubing of cold-rolled steel, just make a note of it.



50-foot television tower made of Armco ZINCGRIP Tubing. When erected, this self-supporting mast is rigid enough to permit a technician to climb to the top to complete installation.

☐ Send me more information on Armco ZINCGRIP Tubing
☐ Send me a copy of the booklet, "Armco Welded Steel Tubing"
☐ Send me a copy of the booklet, "Fabrication of Armco Welded Steel Tubing"

NAME_____

FIRM_____

STREET_____

CITY_____ ZONE_____ STATE_____

ARMCO STEEL CORPORATION

3714 Curtis Street, Middletown, Ohio • Export: The Armco International Corporation

ARMCO®

Table III—Creep-Rupture Properties of Cast Alloys at 1,200 F

Alloy	Condition	Rupture Strength, psi		Rupture Elongation, percent	
		100 hr.	1,000 hr.	100 hr.	1,000 hr.
15-25Mo	As-Cast	35,000	30,000*	42	..
13-19W	As-Cast	37,500	32,000*	3	..
	Heat-treated	40,000	35,000*	3	
18-8Mo	As-Cast	36,000	32,000*	22	
18-8W	As-Cast	16,000*	.....	..	
15-25TiV	Heat-treated	47,000	38,000	4	4
18-5MnCb	As-Cast	51,000	42,000	4	5
18-5MnW	As-Cast	49,000	38,000	8	3
18-5MnWMo	As-Cast	48,000	43,500	9	8
23-3Mn	As-Cast	46,000	40,000	5	1.5
18-5MnMo	As-Cast	46,000	39,000	4	5
15-25TiAl	Heat-treated	48,000	38,000	8	3
16-15MoCu	As-Cast	41,000	36,000*	13	..
12Cb	As-Cast	19,000	14,000	..	..
	Heat-treated	21,000	14,500	24	20
12V	As-Cast	18,700	13,500	..	..
	Heat-treated	21,000	15,000	22	18
12Mo	As-Cast	20,500	14,500	..	..
	Heat-treated	23,000	16,000	13	12
NiMo	As-Cast	46,500	38,500	5	1
18-8WTi	As-Cast	42,000	36,000	10	7*

* Extrapolated Values.

Table IV—Mechanical Properties of Forged Alloys

Alloy	Condition	Tensile Strength (psi)	0.2% Yield Strength (psi)	% Elongation	Rupture Strength, psi and Percent Elongation		Ref.
					100 hr.	1,000 hr.	
15-25Mo	Hot-cold worked	162,000	143,500	16	57,000 — 9%	42,000 — 5%	1
13-19W	Sol.-treated, or Hot-cold worked	114,750 to 155,750	74,500 to 125,000	14 to 32	45,000	25,000 to 32,000	1
18-8Mo	Hot-cold worked	138,750 to 154,000	113,750 to 125,000	24 to 29	54,000 to 62,000 — 2%	37,500 to 50,000 — 3%	1
18-8W	Hot-cold worked	122,900	.....	27	53,000	40,000	2
15-25TiV	Heat-treated	144,500 to 150,000	100,000 to 104,500	21.5 to 28.0	61,000 — 5%	46,000 — 8.5%	3
18-5MnCb	Hot-cold worked	157,750	125,000	23	53,000 — 5%	32,000	1
18-5MnW	Hot-worked	153,750	.....	3.5	56,000	39,000	1
18-5MnWMo	Hot-worked	150,500	.....	13	56,000	40,000	1
23-3Mn	Heat-treated	142,000	101,000	20	56,000 — 6%	47,000 — 5%	4
18-5MnMo	Heat-treated	101,500	61,200	30	46,100 — 14%	39,000 — 9%	5
15-25TiAl	Heat-treated	102,000	81,500	25	35,000 — 39%	25,500	6
16-15MoCu	Annealed	135,000 to 139,200	57,000 to 63,000	44 to 50	54,000 to 58,000 — 2%	33,200 to 36,500 — 8.5%	5,7
12Cb	Not known	92,000 to 120,000	71,000	30	.....	.....	8

References:

1. J. W. Freeman, E. E. Reynolds, and A. E. White. "High-Temperature Alloys Developed for Aircraft Turbochargers and Gas Turbines". Symposium on Materials for Gas Turbines, June 1946, ASTM., pp. 52–79.
2. Frances H. Clark, ***Metals at High Temperatures.*** Reinhold, 1950, p. 155.
3. "Technical Data on Allegheny Ludlum Alloy A-286". Issued 1/9/52, revised 10/20/52. 21 pp.
4. "Technical Data on Discalloy 24". Engineering Report from Materials Engineering Department, Westinghouse Electric Corp., Feb. 1949, 10 pp.
5. N. J. Grant, A. F. Frederickson, and M. E. Taylor. "A Summary of Heat Resistant Alloys from 1200 to 1800 F." Iron Age, Mar. 18, pp. 73–78, Apr. 8, pp. 75–81, Apr. 15, pp. 84–93, 1948.
6. Data obtained at NRL.
7. ***Haynes Alloys for High Temperature Service.*** 1948 and 1950, 96 pp.
8. "British Intelligence Subcommittee Report on Visit to Germany and Austria to Investigate Alloys for Use at High Temperature". Final Report No. 21 (no date).

Sluggish Chemicals Keep Moving Along

Heavy, easy clogging products such as tar, pitch and amonium nitrate will solidify or crystallize in process lines if they are not kept above a minimum temperature. A new approach to this problem is Unitrace, an integrally extruded, steam-traced aluminum pipe. It is the result of joint engineering efforts by Alcoa and Hercules Powder Co. to find a new means of applying heat to product piping.

In contrast to normal methods of heating lines by using an external steam jacket or steam tube to apply the necessary heat, the new pipe is extruded as a single unit from 38-F aluminum alloy The new product is slightly oval in cross section because of the crescent-shaped steam passage adjacent to the product line. The size now available in this new type of process line has the dimensions of 2-in., schedule 40 pipe.

In its original application, the new piping is said to have resulted in the following savings over conventional 2 in. steam jacketed lines: 38 c a foot saved on material; 5 c a foot saved on insulation; and 30 percent reduction in labor costs.

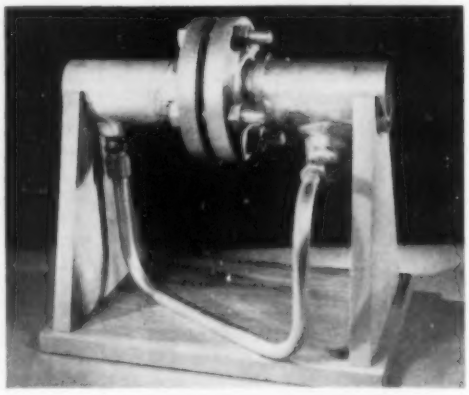
Greatly improved heat transfer properties over normal steam tracing techniques have been noted. The expense of steam jacketing and its installation is eliminated.

Pre-formed insulation will fit the new pipe. In the case of the 2-in. pipe, the new product is designed so that insulation for 2½ in. standard pipe will form naturally. When insulation is used, a smaller size can be used than with the older steam-jacketed piping. But because of improved efficiency, thermal insulation will be unnecessary in many cases, particularly where set quantities of process steam are allocated for tracing purposes.

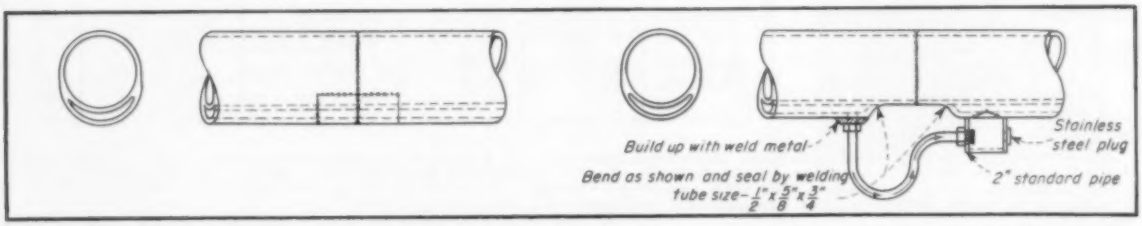
The new piping lends itself readily to shop fabrication of standard lengths. It can be formed easily using conduit tools.

Aluminum Co. of America, 1501 *Alcoa Bldg., Pittsburgh* 19, *Pa.*

CRESCENT-SHAPED SECTION at bottom is the steam line in this new type of product piping. It is extruded as a single unit and conforms to standard 2 in. Schedule 40 pipe dimensions. The unit is amendable to 2½ in. pre-formed, regular pipe insulation.



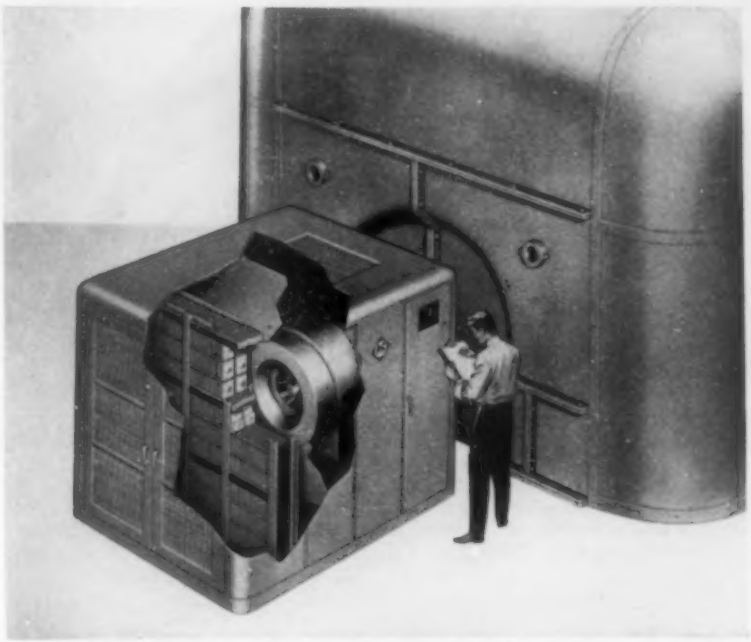
A POSSIBLE METHOD of joining sections. Steam line has been welded shut; welding fittings installed. Tubing carries steam across joint for easier periodic removal.



THREE WAYS OF PUTTING SECTIONS TOGETHER: (Left) Welded joint, eliminating use of fittings. (Right) Again a welded joint, but with steam passage shut and jumper installed across joint.

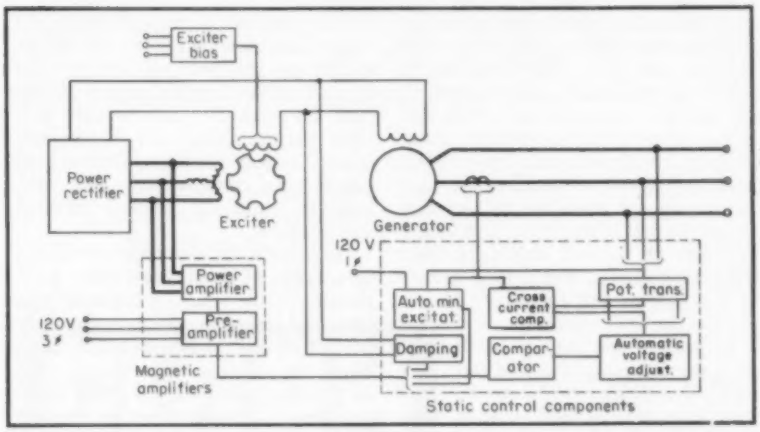
MATERIALS - PARTS

SPECIFIED BY PRODUCT ENGINEERS



NEW EXCITER SYSTEM will look like this when installed at Iowa Power & Light Co. One of the doors leads to a compartment housing the inductor generator. The other leads to the selenium rectifier bank. Generator was installed in 1938.

Exciter Eliminates Maintenance Chores



STATIC CONTROL components within right hand dotted line are identical to static components used with rotating amplifier voltage regulation. The magnetic amplifiers within dotted area on left replace rotating amplifiers in a voltage control system.

In what is reported to be an entirely new exciter system available as original equipment with turbine-generator units or for modernization of older generators, brushes and commutator of the conventional exciter and all rotating windings have been eliminated. An inductor alternator substitutes for the usual d-c machine.

Power for excitation is generated at high frequency and then changed to direct current by a bank of selenium rectifiers. The rotating element of the new a-c exciter is adaptable to overhung mounting on most 3,600 rpm generators in which case couplings, gears and extra bearings are eliminated. And, other than the inductor generator, only static components are used.

When compared with the conventional d-c exciter-regulator system, the new exciter is expected by its maker to virtually eliminate maintenance requirements while providing superior reliability and performance.

The inductor alternator type exciter in the new system is under the control of magnetic amplifiers through a circuit sensitive to the main generator terminal voltage. Selenium rectifiers convert the high frequency output of the inductor alternator to direct current for exciting the main generator field and the exciter series field.

The inductor generator has inherently high reactance and is especially sensitive to lagging power factor loads. The control signal to the magnetic amplifier is obtained from potential transformers on the main generator terminals through a comparator circuit and a magnetic pre-amplifier.

Because the exciter has, in effect, no time constant of its own, the speed of response as a factor delaying restoration of voltage is governed mainly by the very short time constant of the magnetic amplifiers.

The heart of this new excitation system is a 360 cycle inductor generator, which has no windings, commutator or slip rings.

Inductor generators are not new. They have been used to a limited extent for many years. One commercial application has been its use as a high frequency generator supplying power to induction heating equipment.

Allis-Chalmers Mfg. Co., Milwaukee 1, Wis.

CONTINUED ON PAGE 214

Plastic Handles Acids, Oils, Fuels Up To 450 F

A new line of plastic hose and pipe which is said to be chemically inert, light in weight and resistant to elevated and low temperatures is in production on a pilot-plant basis. Designed primarily with the aviation industry and the guided missile program in mind, both of which use corrosive fuels and oxidizing agents, another early application of the hose is expected to be those hydraulic systems requiring non-corroding conduit.

Additional uses were indicated by a leading research organization in the chemical field, whose survey showed that the trend toward higher operating temperatures in the process industries is tending to create a need for pipe having new characteristics.

In line with these findings, two variations of the polytetrafluoroethylene, or "Teflon" resins were modified to favor known outstanding properties and to minimize those which, up to now, have presented real obstacles to its use in hose and pipe.

A seamless extruded tube, reinforced with a braided jacket of stainless steel wire comprise "Resistoflex R-500" hose. R-500 hose coupled with high strength steel fittings becomes R-3800 hose assemblies, designed specifically for high temperature aircraft and jet engine service.

Aluminum fittings are provided where light weight is the primary objective. Elbow fittings, both aluminum and steel, are being perfected to satisfy difficult installation requirements; stainless steel will be used where it is necessitated by the more corrosive or highly reactive fluids.

The higher temperatures and more corrosive fluids encountered in the aircraft and guided missile applications for which the new hose and pipe were designed, required new testing procedures and standards. The various standard pressure, vibration, fluid immersion, and circulation tests were used but instead of the 158 F test temperatures heretofore required, temperatures of 400 F and 450 F were used.

Burst pressure tests normally are run at room temperature on brand new hose assemblies. R-3800 hose assembly pressure ratings were assigned on the basis of burst tests performed at 450 F. In the same manner, the vibration test, in which hose assemblies are vibrated at 2,000 cycles per min to an amplitude of $\frac{3}{4}$ in., was run with oil at 450 F flowing through the lines. The standard fuel immersion test at 158 F was revised to a test at 450 F with the immersion occurring in a pressurized container.

FROM JETS AND GUIDED MISSLES to hydraulic systems and processing lines is likely to be the career of this new line of "Teflon"-lined hose fittings and laminated pipe. The hose is available in a range of seven sizes, from $\frac{1}{4}$ in. through 1 in. Pipe can be ordered in 1, $1\frac{1}{2}$, 2, 3, and 4 in. dia.

An exceptionally severe low temperature test was instituted. Hose assemblies have formerly been assigned service ratings of —65 F on the basis of a test in which they are soaked at that temperature for 72 hr and bent around a test mandrel of specified diameter. After this treatment the assemblies are permitted to warm up to room temperature and then given a proof pressure test. R-3800 hose assemblies were soaked at —110 F, bent to the specified diameter and, while still at this extreme low temperature, proof pressure tested with both fuel and oil.

According to the manufacturer, this test represents probably the severest test of the seal at the fitting attachment that can be devised, especially since the samples tested had a long history of exposure to 450 F both inside and outside the hose assembly.

In attempts to destroy the R-3800 hose assemblies so as to find their ultimate capabilities, some extreme "torture" tests were devised. One of these was a thermal shock test in which hose assemblies were soaked at —110 F; while still at this extremely low temperature, high pressure oil at 450 F was suddenly introduced into the lines.

No hose assemblies failed in any of the tests conducted.

"Fluoroflex-T" laminated pipe is a companion product to R-500 hose. An internal layer of one of the new Teflon formulations is intimately combined with a high-strength reinforcement of Teflon coated glass fabric. Where necessary, and warranted costwise, an outer seal of the same plastic can also be applied.

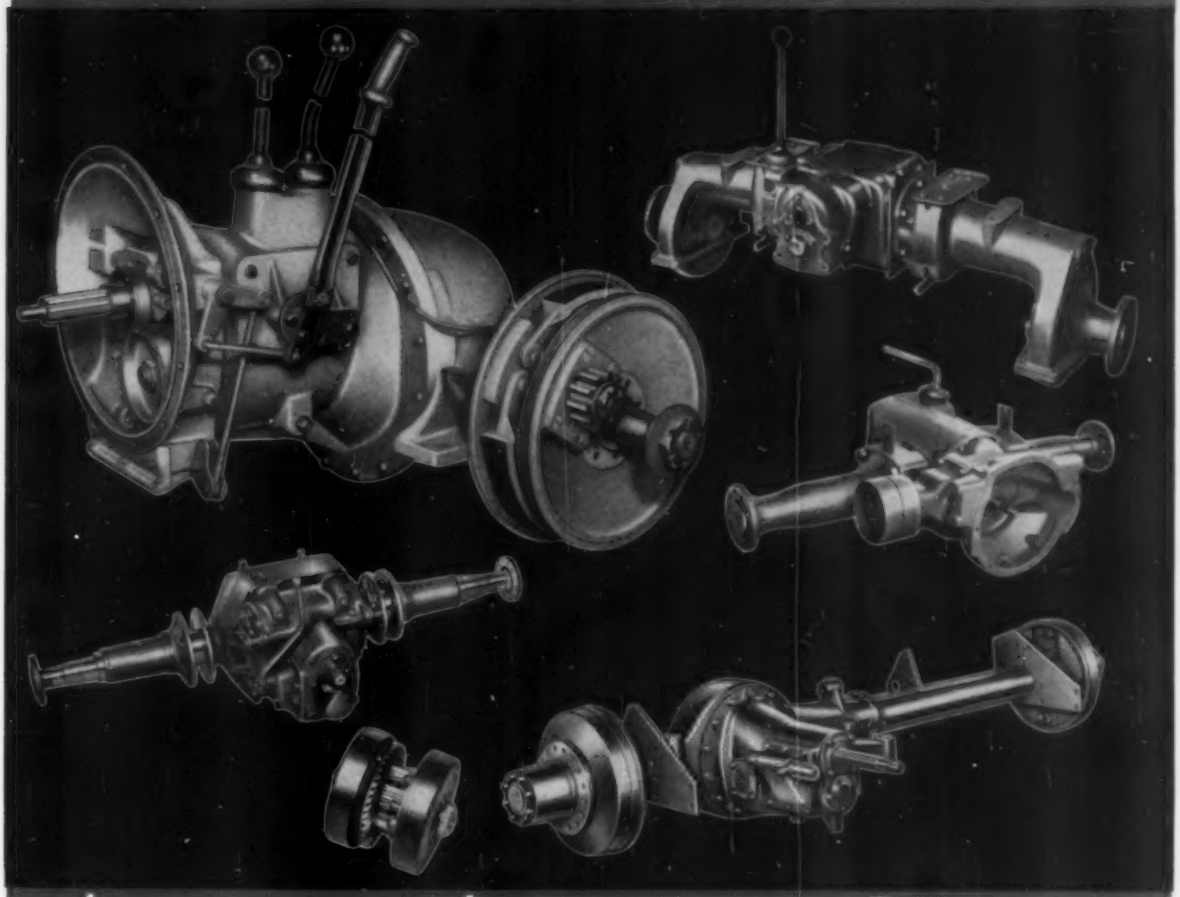
The resultant pipe is lightweight, rugged and non-frangible, and can be readily cut and fitted on the job with the aid of a portable heated flaring tool. As accessories, and to make possible the installation of a complete piping system, a line of corrosion-proof pipe fittings has been developed, including elbows, reducers and adapters.

At present, the new hose is available in a range of seven sizes from $\frac{1}{4}$ in. through 1 in. Three additional hose sizes will soon be added to the line. The laminated pipe is available in 1, $1\frac{1}{2}$, 2, 3, and 4 in. dia. Special sizes of the new Teflon-and-glass fiber product can be produced where requirements are large enough to warrant it.

Resistoflex Corp., Belleville 9, N. J.

CONTINUED ON PAGE 216

"CLASS"
THAT CLAIMS LEADERSHIP



—these CLARK axle-transmission Drive Units

Have you a new product on the drawing board, or an old one that needs a "face-lifting" . . . any industrial, agricultural, heavy duty highway or off-highway unit? . . . Equip it for leadership with a Clark Drive Unit *designed specially for the job to be done* . . . This simple idea of your engineers and Clark engineers working together, drawing on a matchless pool of combined operating and power-transmission experience, makes very good sense. It has been done by several "Class" manufacturers—and it always works!

CLARK EQUIPMENT

IT'S GOOD BUSINESS TO DO BUSINESS WITH

CLARK EQUIPMENT COMPANY

BUCHANAN, MICHIGAN.

Other Plants: BENTON HARBOR • BATTLE CREEK and JACKSON, MICHIGAN

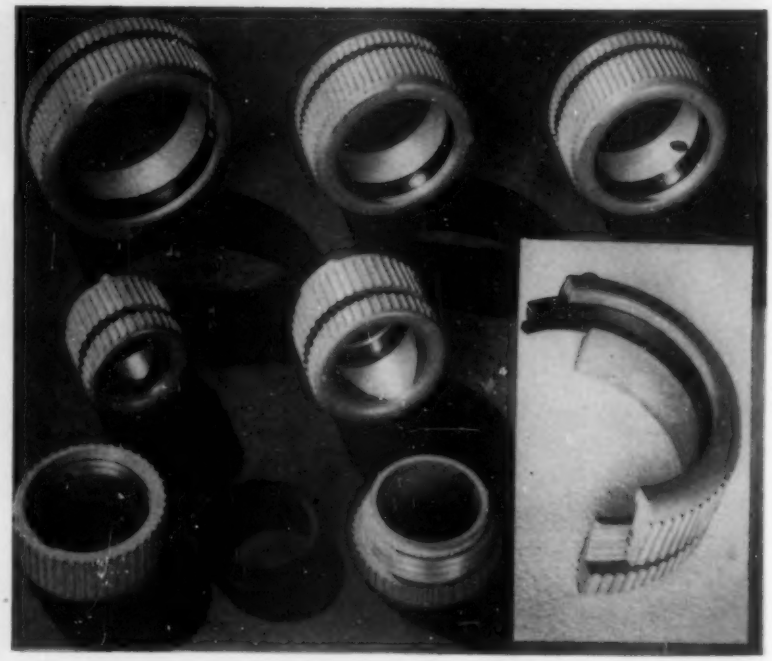
PRODUCTS OF CLARK . . . TRANSMISSIONS • AXLE HOUSINGS • TRACTOR UNITS • FORK TRUCKS and TOWING TRACTORS • ROSS CARRIERS • POWRWORKER HAND TRUCKS • POWER SHOVELS • ELECTRIC STEEL CASTINGS • GEARS and FORGINGS • FRONT and REAR AXLES for TRUCKS and BUSES

Clamps Plastic Pipe and Fittings Together

A new molded plastic clamp effects a tight, permanent seal when sections of flexible plastic pipe are connected by means of insert couplings, tees, ells and adapters. It is slipped over the pipe ends and tightened to force them down onto the serrations incorporated in insert fittings to create a positively leakproof connection.

The new clamp is molded in two separate threaded sections. Butted against a shoulder at the base of the female threads in one half is a synthetic gasket with a V-shaped groove. When the other half of the clamp is screwed down onto this gasket it is forced against the pipe. Consequently a full 360 deg pressure is exerted on the pipe to make it grip the insert fittings tightly. It is reported that connections made in this way are literally stronger than the pipe itself.

This new clamp makes possible the installation of completely plastic pipe lines. Prior to its development, a steel clamp was used for insert connections. Like all Carlon pipe, this plastic clamp is impervious to rot, rust, and electrolytic corrosion and can be used in most adverse conditions. When the unit is positioned, the specially compounded gasket is completely enclosed and therefore protected from fluids, ozone and other deteriorating forces.



The clamp is produced in sizes for ½, 1, 1½, 2, 3, 4 and 6 in. plastic pipe. It is tightened easily by means of a strap wrench and can be removed and reused when pipe installations are changed or dismantled.

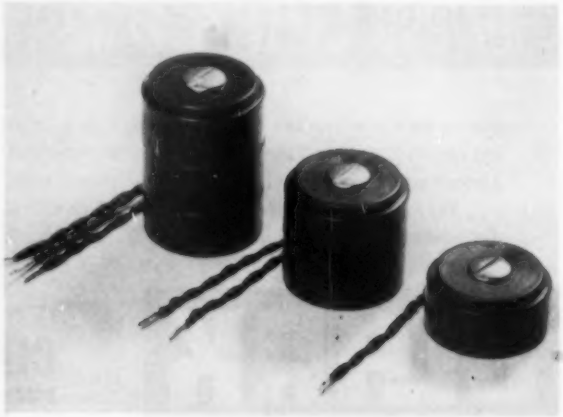
Carlon Products Corp.,
10225 *Meech Ave., Cleveland* 5, *Ohio*

Encasing Toroids Aids Mounting

A new encasement assembly which simplifies the mounting problems associated with toroidally shaped inductors has been developed. An injection molded, high impact strength plastic cup is used in combination with an appropriate disk and machine screw for containing the toroid. This screw is also used for attaching the assembly to the chassis.

In addition to minimizing mounting difficulties, it is said that encasing toroids in this manner insulates, protects and improves the appearance of the encased units. This mounting system is inherently adaptable to the stacking of numerous units for convenience and miniaturization purposes. This is accomplished readily because the individual cases are designed to interlock when placed on top of each other. Subassembly of the stacked units as well as attaching this assembly to the chassis is accomplished in the same manner as used for the single unit. As many units as desired can be stacked in this manner.

No increase in cost over the encased toroids is expected by the manufacturer in furnishing this type of cased unit.



Torocoil Co., 1374 *Mobile Ct., St. Louis* 10, *Mo.*

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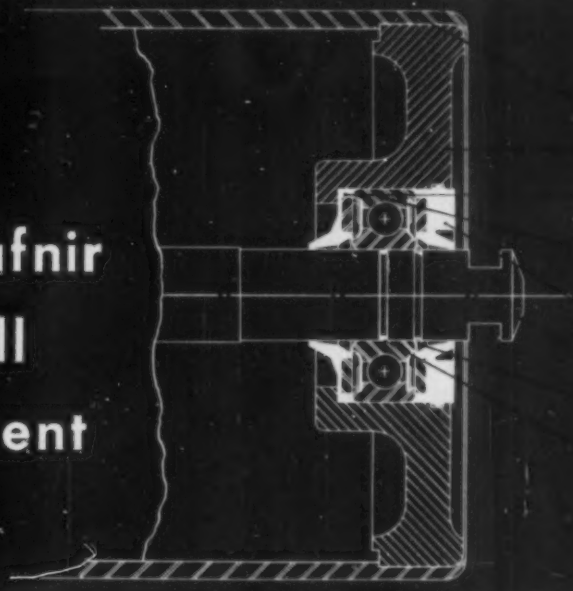
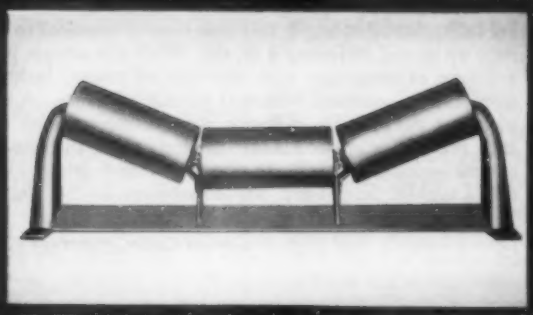
Trouble Fixed Fast...

by Transall-Fafnir Idler Roll Development





The all steel, jig welded frame of this troughing idler insures roll alignment and facilitates belt training. Each idler roll is equipped with two Fafnir Plya-Seal Bearings.

Fafnir-equipped Transall Conveyor, for Mine Run Coal. In daily operation since December 1949 . . . 2600 bearings without a bearing failure to date.

Things began to happen when Transall Designers asked Fafnir Engineers to join them in solving a troublesome conveyor problem. By pooling their experience, the answer was found quickly and simply . . . an improved idler roll with advantages beyond anything available.

Right from the start, the problem was simplified by centering development around Fafnir Plya-Seal Ball Bearings. Factory lubricated and sealed for operation between −60°F. and +200°F, Fafnir Plya-Seal Bearings never need relubrication. The seals are unaffected by moisture and many other contaminants.

Extra insurance against abnormally severe conditions was provided by chrome plating the bearing inner ring to prevent corrosion and abrasion at the point of seal . . . and by the addition of supplementary, resilient bearing closures.

It's another example of the Fafnir "attitude and aptitude" . . . a way of looking at bearing problems from the designer's viewpoint and the ability to supply the right bearing for the need. If you have a bearing problem, why let it drag. Bring it to Fafnir like most people do. Maybe your trouble can be fixed fast. The Fafnir Bearing Company, New Britain, Conn.

FAFNIR
BALL BEARINGS
MOST COMPLETE LINE IN AMERICA

Replaces Hand Splicing of Wire Rope

A new wire rope pressing system is reported to eliminate hand splicing. Using the new system, it is said that a worker can make as many as 20 or 30 splices in an hour, as compared to 6 or 7 conventional splices per hour for a skilled worker using hand methods.

The new pressing system employs an aluminum alloy clamp or sleeve that is squeezed around the wire rope in a special 300 ton hydraulic press. The device is used as a mechanical method of splicing eyes, with or without thimbles, in the ends of wire rope. This "splice" is reported to give 100 percent of the breaking strength of the wire rope itself.

There is also a saving in the length of wire rope needed to make the splice. About 85 percent of the rope length that would be necessary for a hand splice is saved.

The clamp or sleeve in the new system consists of a piece of metal tubing that looks like a heavy bracelet, oval in cross section, with a place for the two ends of the wire rope cable to be clamped together. The sleeve material is a special corrosion resistant aluminum alloy that combines great strength with cold flowing ability under pressure at room temperature.

To make a splice, the wire rope is first measured, cut and inserted in the clamp. Then the clamp is crimped or squeezed around the wire.

A pressed joint is formed without damage to the individual wires. The clamp metal is reported to actually flow into the space between the wires in the strands and between the strands themselves. The clamp becomes a part of the rope.

The splice is water tight, unlike hand splices, where there are always openings between the wires. Submerged in salt water, spliced wire rope is subjected to corroding and rusting forces. Those forces are more easily resisted by this mechanical splice than they are by an ordinary tucked splice.

The new splicing method can be used with a full range of wire rope diameters—up to and including 2 in.

Special 300 ton capacity, motor-operated hydraulic presses are being leased to apply this new type of terminal to wire rope up to and including $\frac{3}{4}$ in. dia. With this unique press, any type of wire rope with any type of center, including fiber, can be squeezed with 100 percent efficiency. A complete set of dies for different rope diameters goes with each press. Clamps are made in Sweden and the dies and special hydraulic presses are also of Swedish origin. Jones and Laughlin Steel Corp. are distributors in this country.

Jones & Laughlin Steel Corp., 3 Gateway Center, Pittsburgh 30, Pa.

Three Larger Roller Chain Sprockets Available

Roller chain sprockets in both single and double hub types are now available in an expanded line of stock sizes for $1\frac{1}{2}$ in. pitch, $1\frac{3}{4}$ in. pitch, and 2 in. pitch chain.

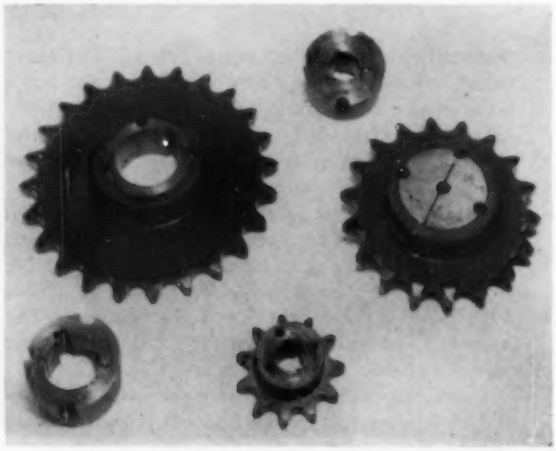
The "No. 120, Type B" (single hub) sprockets are stocked in nine sizes from 13 to 26 teeth with a maximum rating of 75 hp. "No. 120 Type C" (double hub) driven sprockets are stocked in five sizes from 35 to 80 teeth.

The "No. 140 Type B" sprockets are stocked in ten sizes from 12 to 26 teeth with a maximum rating of 95 hp. "No. 140 Type C" come in four sizes from 35 to 70 teeth.

"No. 160 Type B" sprockets are available in eleven stock sizes from 11 to 26 teeth with a maximum rating of 125 hp. The "No. 160 Type C" driven sprockets are made in three stock sizes from 35 to 60 teeth.

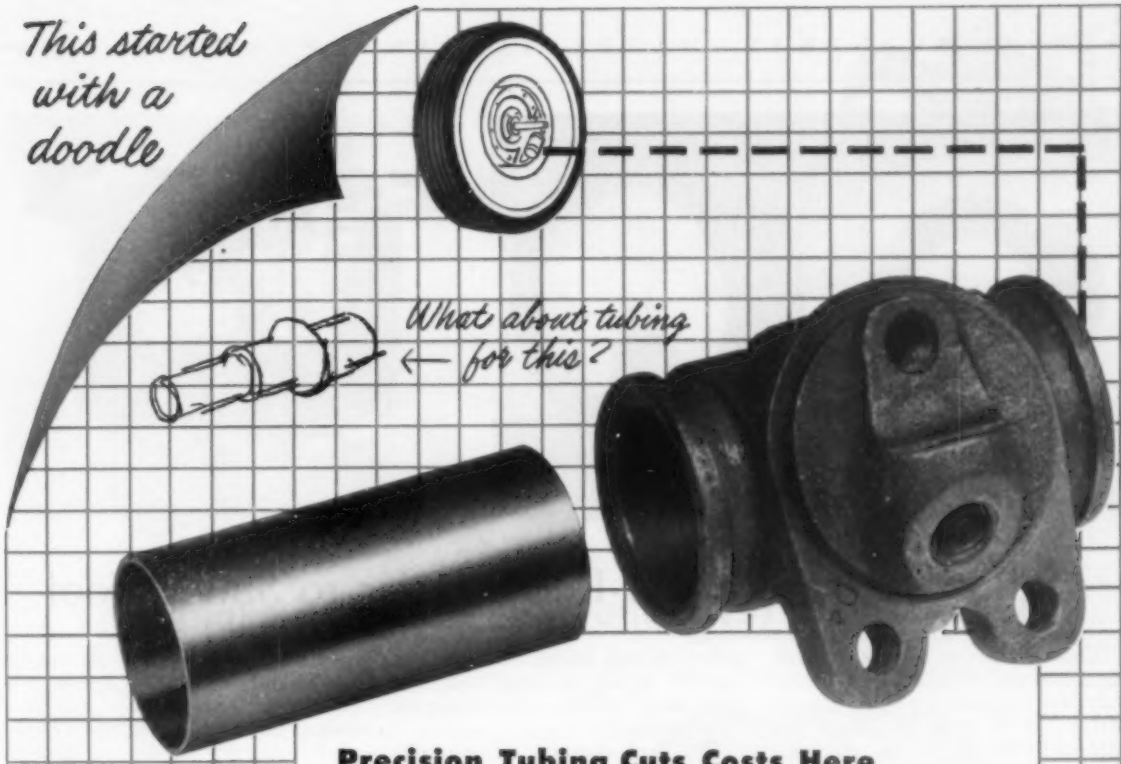
All the stock sprockets in the new sizes up to 26 teeth are 0.40 carbon steel and can be flame hardened.

Only five bushing sizes are required to fit the newly expanded line. They are being stocked by distributors in 54 bore sizes fitting shafts from $1\frac{5}{16}$ to $3\frac{1}{2}$ in. dia in the No. 120 sizes, from $1\frac{5}{16}$ to 4 in. dia in the No. 140 sizes and from $1\frac{5}{16}$ to $4\frac{1}{2}$ in. dia in the No. 160 sizes.



Morse Chain Co., 7601 Central Ave., Detroit 10, Mich.

CONTINUED ON PAGE 220



Precision Tubing Cuts Costs Here —What Can it do for You?

IT'S POSSIBLE to save money for your company and make a better product at the same time when you use precision tubing. Specifically, Republic ELECTRUNITE Tubing.

Autoline Supply Company of Chicago does it this way. The tubing they use for sleeving brake cylinders has to have a smooth surface. No pit marks. No scratches. The tolerance on a 1" cylinder is three and a half thousandths. If the tubing isn't smooth, it means an expensive honing operation.

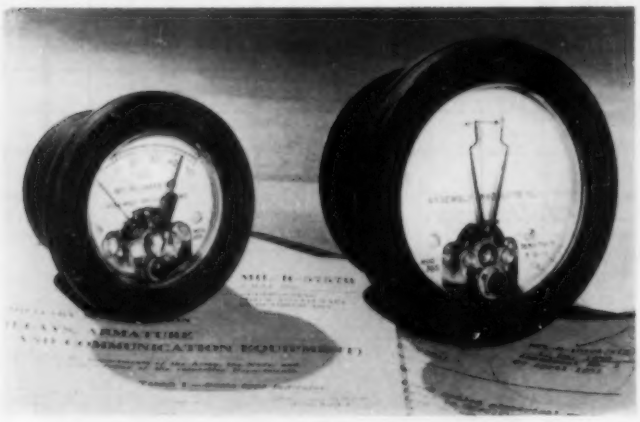
By using Republic ELECTRUNITE Tubing, this operation is eliminated. So is tubing scrapped because of imperfect surface finish. Cylinders perform the way they should. Costs are kept down.

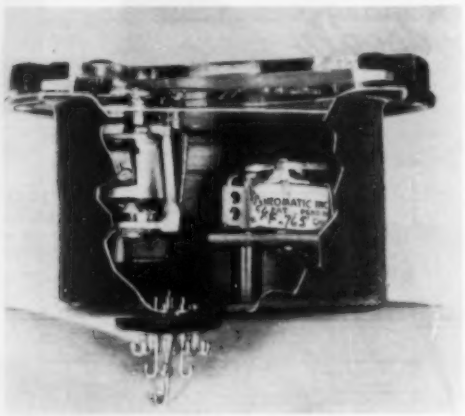
Does this give you an idea for using ELECTRUNITE Tubing in your products to cut material costs, speed production, or turn out better parts? Our engineers will be glad to help you take advantage of this precision tubing in either carbon or stainless steel analyses. Write to:

REPUBLIC STEEL CORPORATION
Steel and Tubes Division
222 E. 131st Street, Cleveland 8, Ohio
GENERAL OFFICES • CLEVELAND 1, OHIO
Export Department: Chrysler Building, New York 17, N. Y.

REPUBLIC ELECTRUNITE TUBING

REPUBLIC STEEL





Lighter Contact Meter-Relay Easier to Shockproof

These instruments are both indicating meters and relays so they are being tested for compliance with portions of MIL-R-5757-B covering relays and MIL-M-10304 for meters. To meet these requirements, they must stand a 50 g shock and vibration of 10-55 cps, 0.03 in. amplitude. They are offered in 2½ in. and 3½ in. models.

The standard contact meter-relay is a D'Arsonval instrument made in all the usually a-c and d-c voltage and current ranges. They have a pair of built-in contacts, one carried on the indicating pointer and the other mounted on a separately pivoted pointer which is adjustable over the entire scale arc. At the lightest touch the contacts snap together through torque from the locking coil. Spring mounting kicks them apart when current in the locking coil is interrupted.

The tiny contacts are platinum-iridium and it is reported that they will make and break up to 15 million times before wearing out. They are normally used at 5-25 dc milliamperes, 75-125 volts, although samples have operated successfully at currents up to 300 milliamperes.

The new contact meter-relays are D'Arsonval movements also, but are made with the magnet as the core instead of with the conventional horseshoe of "Alnico" surrounding the coil. The complete movement, coil, pointer assembly, hairspring, jewels, bracket, and magnet, weighs only 0.8 oz compared with 4½ oz for that of a standard contact meter-relay. Shock-proofing is made easier by this feature, and the new magnet is still strong enough to use in 0.20 microampere and 0.5 millivolt instruments. Movements are so small that slave relays can be mounted in the case.

Contacts can be made to close with increasing current (high limit), decreasing current (low limit), or both (double), and these components can also be made fixed or adjustable.

Assembly Products, Inc., P. O. Box 191, Chagrin Falls, Ohio

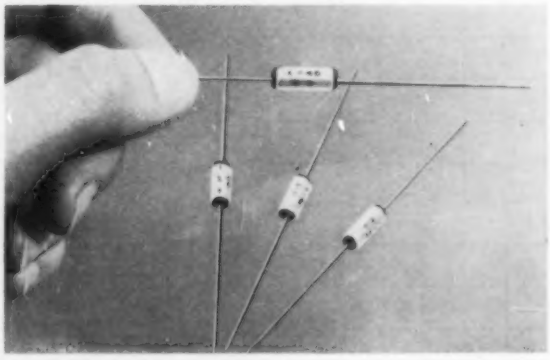
Sub-Miniature Tantalum Foil Capacitors

A sub-miniature tantalum electrolytic capacitor has now been developed which is finding application in both civilian and military communications equipment. The new device is 8/16-in. long and 3/16-in. dia.

According to the manufacturer, the new unit should prove particularly useful in transistor circuits and other uses requiring compactness. These tantalum capacitors cover an operating range from —55 to 85 C. They have a lower leakage current than other electrolytic types. Standard capacitance tolerance is 20 percent.

Power-factor characteristics are said to be excellent even at lowest rated operating temperature. The manufacturer states that wound foil-type construction results in excellent frequency characteristics.

Thirty-five new sub-miniature units are available, ranging in capacity from 0.01 to 8.0 mfd and from 3 to 150 WVDC in both polarized and non-polarized types.



Cornell-Dubilier Electric Corp., South Plainfield, N. J.

CONTINUED ON PAGE 222

Make it **WEIGH LESS** and **LAST LONGER** with

N-A-X

HIGH-TENSILE STEEL

You can design light weight, longer life, and economy into your products by including N-A-X HIGH-TENSILE in your plans.

- It is 50% stronger than mild steel.
- It is considerably more resistant to corrosion.
- It has greater paint adhesion with less undercoat corrosion.
- It has high fatigue life with great toughness.
- It has greater resistance to abrasion or wear.
- It is readily and easily welded by any process.
- It polishes to a high lustre at minimum cost.

And with all these physical advantages over mild carbon steel—it can be cold formed as readily into the most difficult shaped stamping.

Sound like something for you? Ask for full facts and think of N-A-X HIGH-TENSILE when you re-design.

GREAT LAKES STEEL CORPORATION

N-A-X Alloy Division • Ecorse, Detroit 29, Michigan

NATIONAL STEEL CORPORATION

A Miniature Potentiometer That Works On D-c

A miniature, precision sine-cosine potentiometer which will operate on direct current has been developed and is now available for industrial use. It is a resistance device, which works on the principle that the wiper voltage is proportional to resistance. Therefore, unlike magnetic resolvers, which also perform the sine-cosine function but can give out only a-c voltages, it will operate on either alternating or direct current without booster or compensating amplifiers.

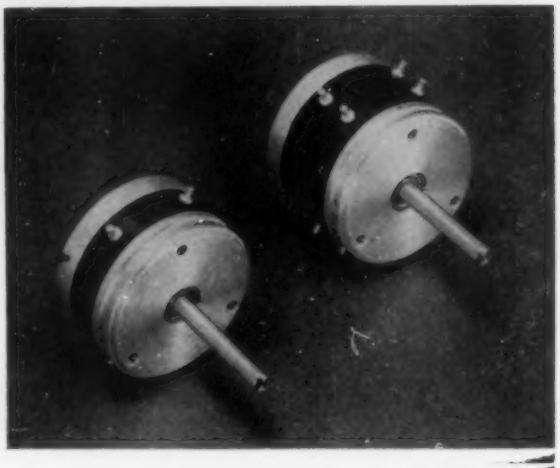
The new unit is claimed to be the smallest packaged potentiometer ever produced which will perform the sine-cosine function at high impedance levels and without loss of resolution. It measures 1 3/32 in. in diameter by 11/16 in. in length and weighs only 1 oz. It can be operated at extremely high shaft velocities without producing phase distortions or amplitude modulations. Because of its small size and great accuracy, it is now being used in electronic computer system designed for gunfire control, navigation and other automatic controls.

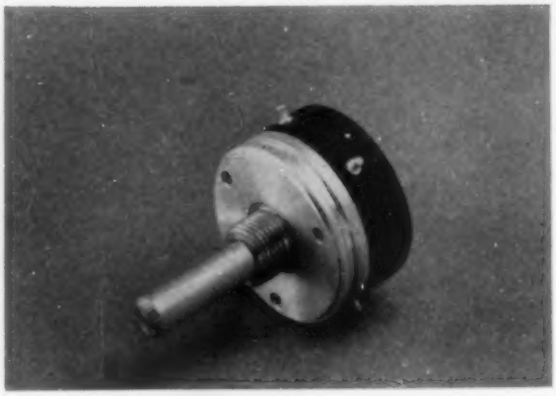
The new potentiometer incorporates the non-inductive carbon film resistance element, which has been proved in use during the past several years. A unique method of depositing the carbon film on the resistance element makes possible the virtually infinite resolution of this unit as well as its extremely low noise-level performance.

The performance of the sinusoidal function is accomplished by a combination of mechanical-shaping and potential-field-distribution techniques applied to the carbon film. The transition from zero to finite slopes is achieved without abrupt steps in output. Both sine and cosine outputs are produced simultaneously by means of two electrically independent wipers spaced 90 deg apart. If two sine and two cosine outputs are desired, four electrically independent wipers can be used, also spaced 90 deg apart.

Two models of the new potentiometer are being produced. The standard model is equipped with double ball bearings and has a flange-type servo mounting. Two or more potentiometers can be ganged in factory-assembled units without loss of mechanical or electrical accuracy. Ganged units have no backlash since they have a common shaft, which may be double-ended.

A modification of the standard model is equipped with a sleeve bearing and may have either a bushing or flange-type mounting. Shaft-locking bushings, knob flats and screwdriver slots are available as well.





Shaft extensions are limited to one end only. With the model having a sleeve bearing, ganging is restricted to two sections, which are factory assembled and phased.

Computer Instruments Co., 1964 Utica Ave., Brooklyn 34, N. Y.

A NEW TESTER for spotting defective insulation, grounds, or shorts gives a buzzer and light signal without arc-burning plated surfaces. The tester has retracting test prods with pistol grips, test leads anchored with bayonet connectors for easy replacement if cut, on-off switch, pilot light and pointer knob for selecting any one of six testing voltages between 500 and 2500 v, ac. Operates from a 115 v, 60 cycle outlet and weighs less than 6 lb. Slaughter Co., Piqua 4, Ohio.

A NEW LOCK NUT with free spinning characteristics is said to be able to ride over corrosion products deposited on threads and bolts and screws, thus lessening galling and seizure problems normally experienced in high temperature applications. They are reported to withstand temperatures up to 1600 deg F. Sizes: 10-32 NF-3 through $\frac{3}{8}$-24 NF-3. They meet government specification MIL-S-5059 and specification AN-126. Write to: Nutt-Shel Co., Inc., 811 Airway, Glendale, Calif.

A NEW COMPOUND OF "BUNA N" is said to have outstanding resistance (300 to 325 deg F), good oil resistance properties and very low compression set at elevated temperature. It is also flexible as slow as —40 deg F. Other high physical properties include tensile strength of 2500 psi, longation of 350 percent, and durometer of 70 points, making it ideal for seals in transmissions, power steering and other similar types of applications. Goshen Rubber Co., Inc., Goshen, Ind.

CONTINUED ON PAGE 224

Zero maintenance

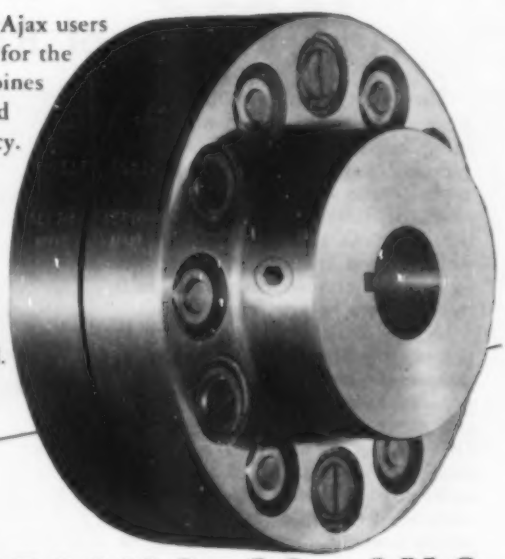
AJAX

RUBBER-BRONZE BUSHED FLEXIBLE COUPLINGS

The experience of hundreds of Ajax users throughout industry has been responsible for the statement—*"Maintenance Zero"*. Ajax combines long life, graphited bronze bearings and steel studs with rubber cushioned resiliency.

Every direct-connected machine deserves the protection of Ajax Flexible Couplings. Bearings, armatures and other expensive working parts are safeguarded by Ajax positive resilient drive. Down-time of machines and even entire departments is prevented.

Write for new Catalog.



AJAX FLEXIBLE COUPLING CO. INC.

Representatives in Principal Cities

WESTFIELD, N. Y.

Pressure Monitor Gives Calibrated Readings

A new pressure monitor that is reported to give accurate, calibrated readings of any dynamic pressure can be used with any two or four arm strain gage transducer and standard oscilloscope. It is specifically designed, however, to take advantage of the unusual accuracy, frequency response and resolution claimed for the Norwood Controls Model EP pressure pickup.

If the sensitivity of the transducer being used is known in terms of microvolts per volt per psi, the pressure monitor calibration system can be utilized to indicate pressures in psi without recourse to any other calibration procedure. The type of calibration circuit used allows static as well as rapidly fluctuating pressures to be measured accurately.

The calibration circuit provides a reference pip at any point throughout the range of the instrument and compensates for non-linearities in all subsequent circuitry. This pulse can be generated at any time without returning to zero pressure on the pickup. A second position of the calibration circuit switch generates a zero pressure pulse to indicate drift or the presence of static pressure.

The monitor may be set to read in percent of full scale of transducer output or directly in pounds per square inch. Either procedure may be used but percentage readings should always be used with other transducers.

The instrument contains a plug-in, two-stage amplifier. The self-contained d-c bridge power supply eliminates power frequency interference. The amplification is 100 with high degenerative feedback—flat from 1 to 25,000 cps ±2 percent, usable from 0.3 to 50,000 cps.

Effective shock mounting is said to be capable of reducing microphonics down to a negligible level.

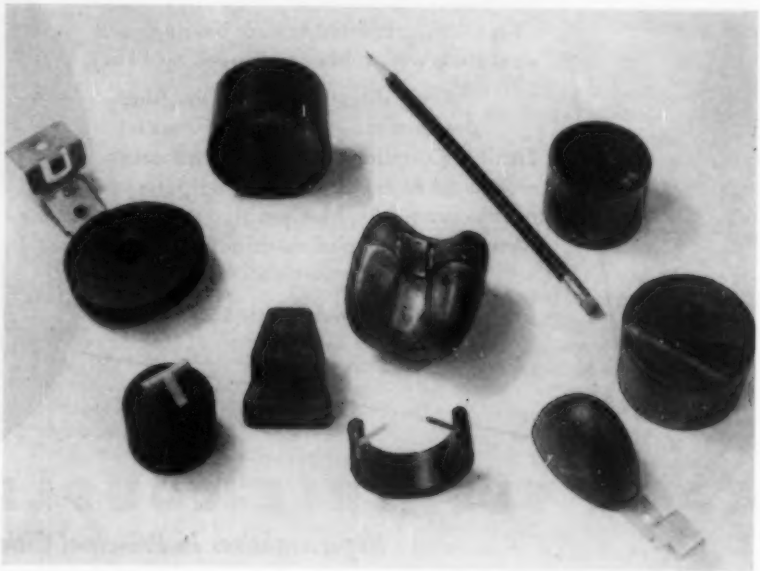
Control Engineering Corp., Norwood, Mass.

Floats of Rigid Cellular Rubber

These floats of rigid cellular rubber were first developed for carburetors using aircraft fuels. They are now gaining acceptance for various new applications, and the manufacturer states that the chief reason for this is the material's permanent buoyancy, which derives from its rigid structure of myriad non-interconnecting cells rather than a hollow form.

Density of the rigid cellular rubber ranges from 5 to 20 lb per cu ft with compressive strength from 30 to 300 psi, depending upon density. Buoyancy may be altered by varying density. The material compounded for carburetor floats gains but a few milligrams under conditions of 30 psi for 72 hr when immersed in SR-6 test fluid (5 percent benzene, 15 percent xylene, 20 percent toluene, and 60 percent diiso butylene).

The Sponge Rubber Products Co., Shelton, Conn.



CONTINUED ON PAGE 226

STAINLESS STEEL FOR KITCHENS

McLouth
STAINLESS
Steel

High quality stainless sheet and strip steel . . . for the product you make today and the product you plan for tomorrow.

McLouth Steel Corporation
DETROIT, MICHIGAN
Manufacturers of Stainless and Carbon Steels

Time Delay Timers

Interval Timers

Re-Cycling Timers

Running Time Meters

MOST COMPLETE LINE OF INDUSTRIAL

TIMERS for automation

The individual requirements of each automation problem are best met by selecting timers designed to perform specific functions. Whatever your timing-control problem, Industrial Timer Corporation can meet it with one of its standard timers, a combination of its standard units, or by designing an entirely new timing element. Our Engineering Department not only originates new designs, but also develops modifications to meet our customers requirements.

We manufacture a complete line of timers in these 4 broad classifications:

TIME DELAY TIMERS • RE-CYCLING TIMERS
INTERVAL TIMERS • RUNNING TIME METERS

Our large stocks of 17 basic types from which we have developed over 660 combinations to date, enables us to make rapid deliveries in most cases . . . and excellent deliveries on special orders. Our automation timer specialists will be happy to discuss your automation timer requirements. Your inquiries will receive prompt attention.

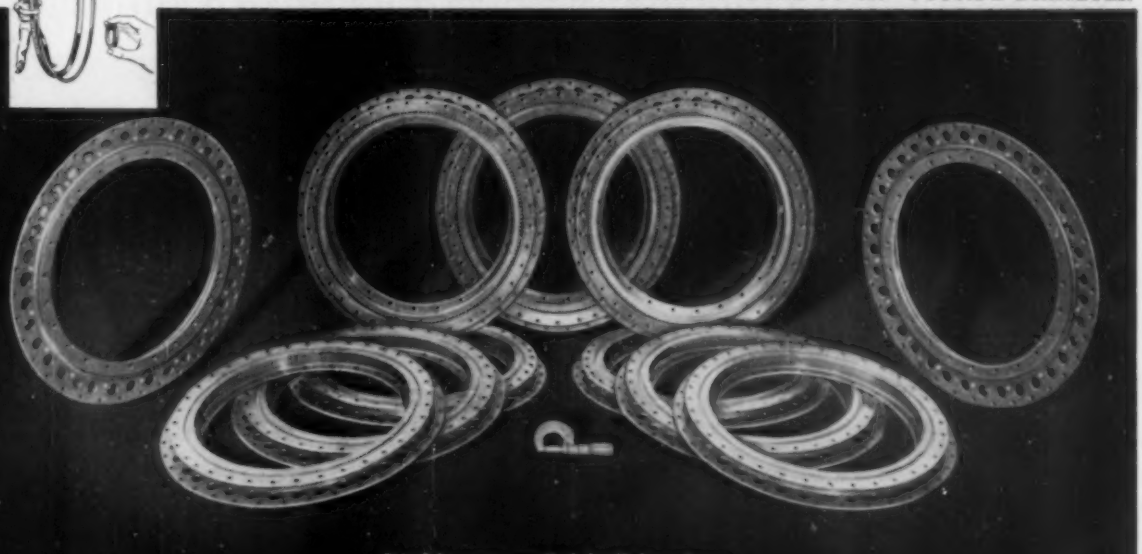
Timers that Control the Pulse Beat of Industry

INDUSTRIAL TIMER CORPORATION

INDUSTRIAL TIMER CORPORATION
131 OGDEN STREET, NEWARK 4, N. J.

Contact KAYDON Muskegon

FOR ALL TYPES OF BALL AND ROLLER BEARINGS: 4" BORE TO 120" OUTSIDE DIAMETER



Double-row radial ball bearings
11.375" x 16.000" x 1.062"

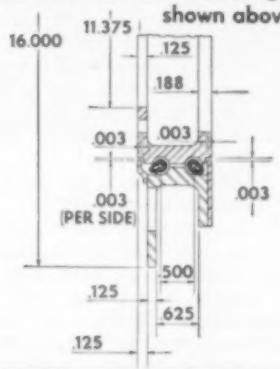
Pattern for precision...and profit

Make it standard procedure to contact Kaydon for special bearings

Ultra-precise, light weight bearings that perform to exceptionally high standards, yet require minimum space, are KAYDON's specialty. Today, KAYDON offers you unmatched experience in the design of special, thin-section and/or high-precision bearings. Then, too, KAYDON has specially developed production facilities to build these bearings...economically ...on either a custom or volume basis.

Follow the lead of many prominent manufacturers—make it standard practice to consult KAYDON of Muskegon on bearing problems. You'll find it pays in terms of time, money and the performance of your product.

Details of thin section bearings shown above—



KAYDON Types of Standard and Special Bearings:
Spherical Roller • Taper Roller • Ball Radial • Ball Thrust • Roller Radial • Roller Thrust • Bi-Angular Bearings

THE KAYDON ENGINEERING CORP.

MUSKEGON • MICHIGAN

PRECISION BALL AND ROLLER BEARINGS

CAA Approves Silicone Rubber-Fiberglass Connector

A new silicone rubber-fiberglass duct connector has been granted CAA approval as an acceptable replacement for metal bellows in aircraft supercharger inlet ducts.

The new flexible connector withstands compression, expansion and misalignment, and at the same time offers improved resistance to high pressures and to operating temperatures from —100 to 700 F and higher. Because of its greater flexibility under all conditions, the silicone-fiberglass connector successfully withstands the effects of vibration and torque motions which in many instances are said to have caused premature failure of metal bellows.

Fabricated from material designated by the maker as "ArcoSil", the new duct connector offers considerable saving in weight, is comparatively low in cost and due to its exceptional flexibility can be easily installed. Standard hose clamps are satisfactory for most installations.

To successfully establish acceptability under CAA requirements for a fireproof and fire-resistant part for use in the aircraft engine application, the new connector was subjected to severe fire tests. In the test set-up, torch heat of 2,000 F was applied to the connector's external surface for a period of 15 min. In one phase of the test, an internal pressure of 13 psi with an air flow of 21 lb per min at 250 F simulated operating conditions. In the static phase of tests there was no airflow through the connector. At the end of the 15 min period, the test coupling was subjected to severe flexing, and internal pressure increased to 40 psi with no leakage or failure of the part.

Inspection of the ducting following the test indicated some damage to the outer layers of the ArcoSil coupling, but inner layers were still intact and flexible. The CAA approved the part as fireproof, fire resistant and acceptable for the application in the fire zones of the airplane.

Arrowhead Rubber Co., 2340 Curry St., Long Beach, Calif.

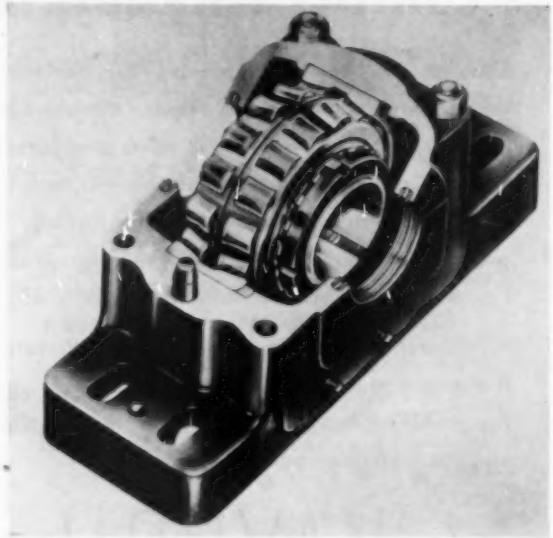
Self-Aligning Mill Bearing

The extra-heavy construction required in roller bearings to be used in the type of industrial equipment found in steel rolling mills, mines and foundries and the more smoothly operating refinements of the self-aligning design are reported to have been incorporated in a new line of "mill bearings". While the new components have heavy sections, especially rugged bases and caps and large studs, dowels and mating surfaces, their bearing design permits them to adjust immediately in all directions.

Full load-carrying capacity is said to be assured, even when minor shaft deflections and normal inaccuracies of mounting occur. This feature is inherent in the design, no auxiliary parts such as shims and aligning rings are needed. This reduces maintenance and simplifies stocking of parts. If changeovers should require disassembly, no adjustment is needed. The bearing adjusts automatically for immediate service when placed in the housing.

The split housing that features the new mill bearing facilitates installation, making it virtually foolproof and requiring only standard tools. Rolls can be changed without altering base settings. However, slotted bolt holes in the base make adjustment easy. Ready inspection of the complete bearing is possible by simply removing the bearing cap.

Spiral steel seals provide effective retention of either oil or grease lubricants. Housing seal fully protects all moving surfaces, which are centrally lubricated from a common reservoir. Pillow blocks are designed for equipment involving individual or centralized lubricating systems.



These new mill bearings are made in a selection of models for use with a variety of shaft sizes ranging from $2\frac{7}{16}$ to $6\frac{5}{16}$ in. diameter.

Link-Belt Co., 307 No. Michigan Ave., Chicago 1, Ill.

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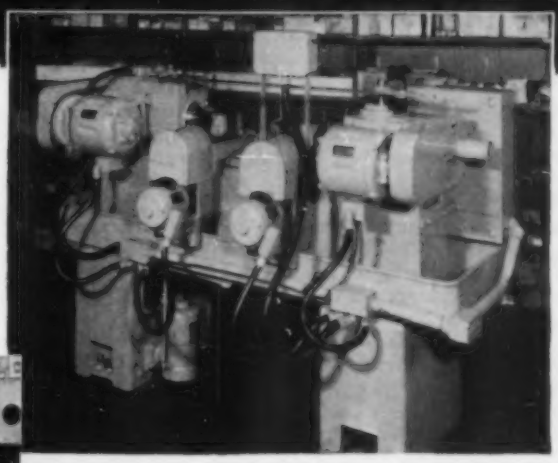
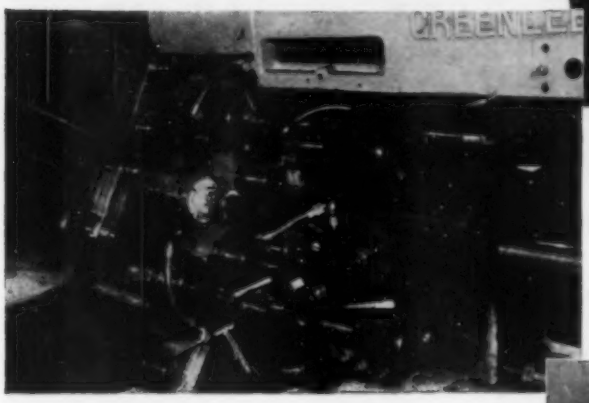
For safety, convenience and economy use FLEXON METAL HOSE on jobs like these . . .



for wiring . . .

FLEXON MACHINE TOOL CONDUIT

Consisting of a rugged flexible metal hose liner with a durable polyvinyl cover, FLEXON Machine Tool Conduit meets the severest requirements for the wiring of all types of machines. It is liquid-tight . . . extremely flexible . . . unaffected by vibration . . . and has a smooth bore that prevents abrasion. Sizes, ⅜" through 2", I.D., cut lengths or mill lengths to 225 ft. May be used with standard rigid conduit connectors. Write for bulletin.



for coolants . . .

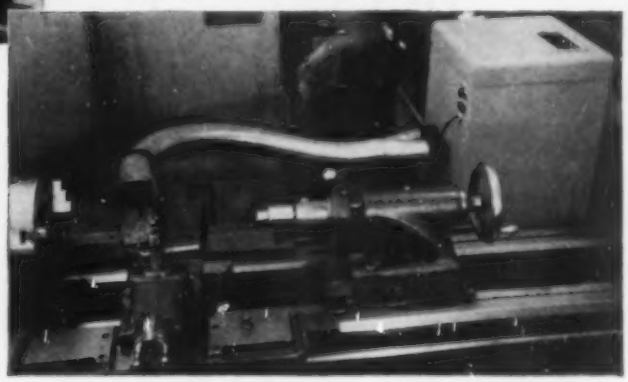
FLEXON *Stay-Put* COOLANT HOSE

Stay-Put Coolant Hose is specially designed interlocked hose that maintains any adjusted position for conducting coolants to work in process. It is leakproof and easily adjustable by light hand pressure. Five standard diameters, ⅛" through ¼"; nine standard lengths 6" through 36". Available with choice of fittings. Write for bulletin.

for ducting . . .

FLEXON *Interlocked*
FLEXIBLE METAL HOSE

Rex Tube RT-6 is a fully interlocked flexible metal tubing particularly suited for exhaust or blower ducting. Widely used for carrying off grinding and buffer dust, and in similar applications. Sizes, ½" through 8", I.D., cut or mill lengths. May be welded to pipe thread fittings or special fittings or may be used with standard hose clamps. Write for data sheet.



IN ANY SERVICE where flexibility must be combined with the rugged durability of metal, specify FLEXON Metal Hose. For hydraulic lines, air lines or any fluid conducting line that is subject to motion, vibration, misalignment or expansion and contraction, there is a FLEXON hose type to meet the need. FLEXON hose is available in diameters from ¼" through 24" and for pressures from vacuum to 18,000 psi (burst). Write for a copy of Catalog No. 130 which gives specifications for all types of FLEXON Metal Hose.

Flexonics *Corporation*

CHICAGO METAL HOSE DIVISION

1351 S. THIRD AVENUE · MAYWOOD, ILLINOIS

FORMERLY CHICAGO METAL HOSE CORPORATION

In Canada: Flexonics Corporation of Canada, Ltd., Brampton, Ontario

Flexon identifies products of Flexonics Corporation that have served industry for over 52 years.

Flexible metal hose

Expansion joints

Aircraft components

Metallic bellows

Voltage Divider Makes New Voltmeter Available

Two new resistive voltage dividers have maximum inputs of 2,000 and 20,000 v respectively, and input impedances of 10^{12} ohms.

These voltage dividers are reported to make available a new type of high-impedance d-c kilovoltmeter. Several unique features are cited, including unusual portability, polarity sensitivity, a very short time constant, and a wide selection of voltage ranges. The new dividers are designated "No. 2006" and "No. 2007".

This new voltmeter is the d-c vacuum tube type with input impedances of over 10^{14} ohms and two voltage ranges. In the model illustrated, linear scales of 0-2 and 0-8 v are provided; by plugging a 10:1 ratio voltage divider over the high terminal, 20 and 80 v ranges are added.

The new dividers add ranges of 200, 800, 2,000, and 8,000 volts. A second model of the "Electrometer" can measure up to 20,000 v, using the same accessories supplied by the maker with the 2,000 v max. input unit.

Typical applications for the new equipment are in measuring voltages on cathode ray tubes, television picture tubes, X-ray and radiation components and equipment, leakage of high-voltage insulators, and testing the voltage breakdown of cables.

Keithley Instruments, 3868 *Carnegie Ave., Cleveland* 15, *Ohio*

High-Voltage, Low-Frequency Litz Cable

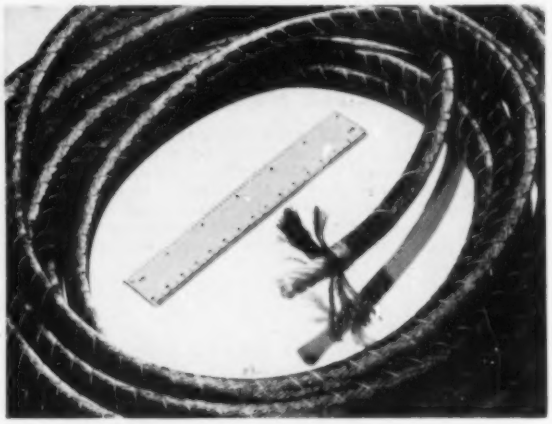
Specialized Litz cables for high voltage applications in the 20 to 400 kc region are being wound on dielectric cores of rope-like construction formed from a variety of plastic films. Diameter limitations of the production equipment are $\frac{1}{8}$-in. core dia min, 2-in. core dia max.

Typical cables produced have included copper conductors of 33 and 38 gage laid on the core with a spiral of three turns per foot, although these specifications can be varied fairly widely. A maximum of 125 multi-conductor strands can be applied.

Conductors of nylon-enamel insulated wire can be made individually continuous to extremely rigid specification requirements.

Polyethylene, "Mylar", or other plastic core materials are used, depending upon requirements of cost, operating temperature, fungus resistance and other service factors.

U. S. Plastic Rope Co., 2581 *Spring St., Redwood City* 10, *Calif.*

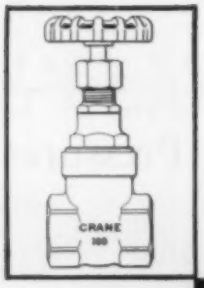


A NEW, RAPID DISCONNECT POWER PLUG and receptacle for use on any mobile, portable or stationary prime power source has two 200-amp contacts for No. 0 cable with 110 to 44v service. The cable entry is watertight sealed with a screw tightened clamp and the shell is steel and synthetic rubber for both strength and resiliency. Spring-actuated snap covers close when not in use and also have a locking arrangement. Silver plated copper alloy contacts may be removed for soldering, inspection, or replacement. Cannon Electric Co., 3209 Humboldt St., Los Angeles 31, Calif.

BERYLLIUM-COPPER springs and rings are available with localized silver contact deposits, bonded together by a method said to preserve all the spring metal's properties. Elimination of overall electroplating is reported to lessen stiffening. Instrument Specialties Co., Inc., 232 Bergen, Little Falls, N. J.

CONTINUED ON PAGE 230

NEW* brass gate valves



No. 410,
100-Pound

No. 438,
125-Pound

by

CRANE

* NEW SHAPE...
NEW STRENGTH

No. 437,
150-Pound

for 3 All-Time CRANE favorites

Here are valves that didn't have to be changed . . . because each has long been the best in its class. But Crane found ways of improvement to give you an even better buy for your brass valve dollars.

For example—here is greater strength, greater rigidity, made possible by the new cylindrical upper body . . . the same basic shape as high-pressure steel valves. Here, too, is an improved stuffing box that screws *into* the bonnet—also better stem support to assure truer alignment and minimize wear on the packing.

And not to be overlooked is their clean, modern appearance—a very desirable advantage for all of your "exposed" installations. Sizes ¼ to 3 in. Ask your Crane Representative all about this improved brass valve line next time he calls.

just off the press...
new four-page folder with complete facts including sizes, prices and dimensions. Send for yours today. Ask for Brass Valve Folder AD1944.

THE BETTER QUALITY...BIGGER VALUE LINE...IN BRASS, STEEL, IRON

CRANE VALVES

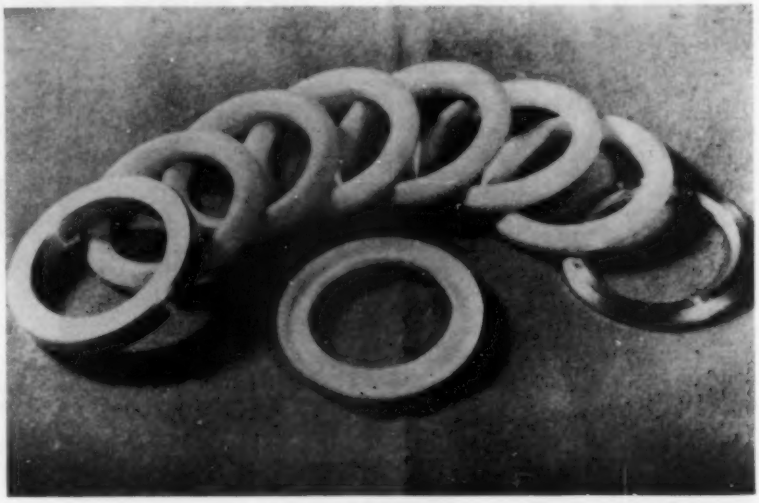
CRANE CO., *General Offices:* 836 S. Michigan Ave., Chicago 5, Illinois
Branches and Wholesalers Serving All Industrial Areas

VALVES · FITTINGS · PIPE · PLUMBING · HEATING

Tight Seal Even at Low Pressures

Packing rings made of "Teflon" have been announced which are said to make possible the design of smaller and lighter units by reducing the packing gland length and diameter. A production-line item, these rings are believed to be more economical than present Teflon packing rings, and can be installed in existing units. They are chemically inert and suitable for use in temperatures from —150 to 550 F. They have a natural "slipperiness" which it is claimed reduces friction.

The resilience of the new packing material is said to be so great that even low pressures exert a flattening action, forcing the cone-shaped segments to bear outward against the wall and inward against the shaft with sufficient pressure to maintain a seal, yet creating the least possible friction. Less pressure is needed to cause flexing than is required for deformation.



Reid Enterprises, 3715 Santa Fe Ave., Los Angeles 58, Calif.

Molded-To-Shape Glass Fiber Insulation

Glass fiber insulation is being molded to fit regular and irregular surfaces and shapes and is available ready to apply to parts and components as a normal part of assembly.

These new insulation parts can be molded in any size up to 8 x 10 in., in densities varying from 2 to 10 lb per cu ft, and thicknesses varying from $\frac{1}{8}$ in. up, depending on density. Firmness and rigidity increase with density. Upper temperature limit is 350 F.

Gustin-Bacon also furnishes die-cut glass fiber insulation (with or without facing material attached) as well as a snap-on type of pipe insulation. This molded one-piece pipe insulation is now available in a variety of pipe sizes ranging from 2 to 24 inch.

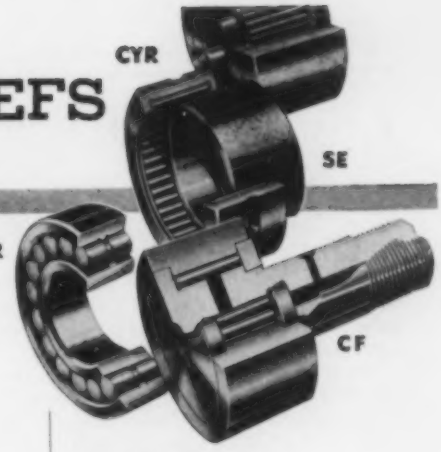
Gustin-Bacon Mfg. Co., 210 W. 10th St., Kansas City, Mo.

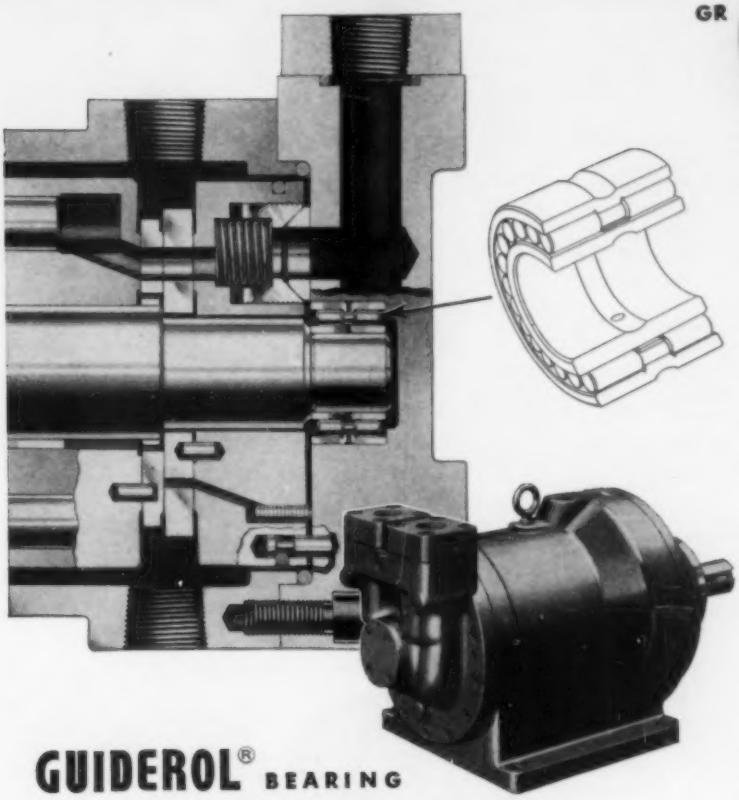
CUSTOM MOLDED SILICONE RUBBER PARTS are now available from Stillman Rubber Co., 5811 Marilyn Ave., Culver City, Calif. They are being made to commercial and government specifications by transfer, injection and compression molding. Services on these new parts include compound formulation, mold-making and full responsibility from blueprint to finished part. Stillman bonds rubber-to-metal to tolerances as close as 5 microfinish.

A MIXTURE OF pulverized aluminum in a plastic base is said to make possible metallizing surfaces without heat. Used for tanks, coils, ducts, piping. Emjay Maintenance Engineers, 327 Union Ave., Rutherford, N. J.

CONTINUED ON PAGE 232

McGILL BEARING BRIEFS





GUIDEROL® BEARING

used in pilot model Oilgear Motor

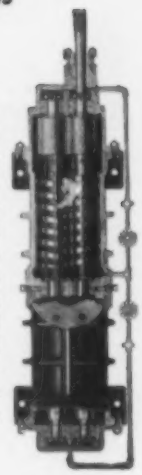
SHOWS NO WEAR AFTER 4000 HOUR TEST

The Oilgear Company, Milwaukee, Wisconsin, a regular McGill bearing user, has been testing a pilot model of a new 60 HP Axial Type Hydraulic Motor equipped with Guiderol Bearings for over a year. After 4000 hours of full load operation, the Guiderol Bearing used on the pilot end of the motor shaft was removed and inspected. It was still in perfect condition showing no internal wear.

This new line of lighter and faster operating axial piston units take advantage of the Guiderol bearing's assured freedom from skewing and extra load capacity in reduced radial bearing space.

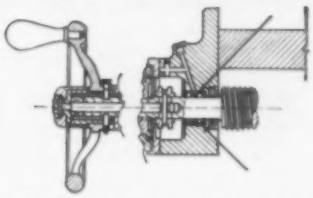
Mr. Ernst Wiedmann, Oilgear Chief Engineer, is enthusiastic about the performance of the Guiderol Bearings. He says: "They are the best full-type roller bearings for our hydraulic pumps and motors." As a result he is changing old specifications for this type of bearing to Guiderol and including Guiderol Bearings on all new developments.

WARREN-QUIMBY ADOPTS GR BEARINGS FOR MAXIMUM RADIAL LOADS



Warren Steam Pump Company has adopted Guiderol Bearings at five points of maximum radial load in this Warren - Quimby Vertical Screw Pump. The Guiderol Bearings have more load carrying capacity in the limited space available and enable vertical mounting of the pump without roller skewing or locking.

KEARNEY & TRECKER FINDS LIFE FACTOR INCREASED IN TABLE FEED APPLICATION

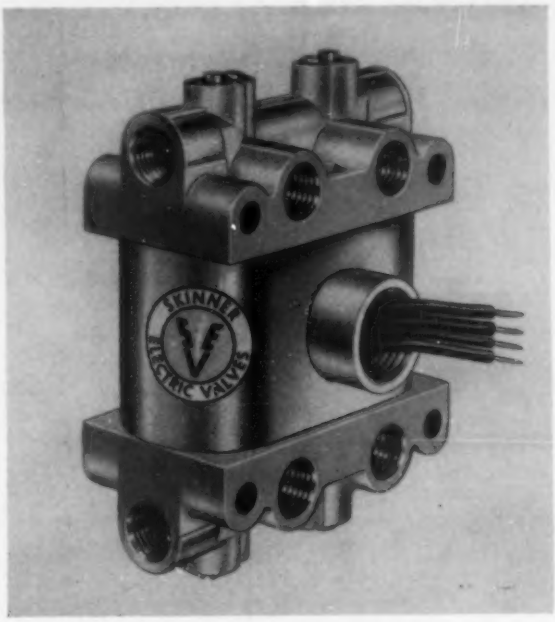


The life factor of the shaft bearing on the table feed screw of Kearney & Trecker Milling Machines has been increased by the simple process of changing to Guiderol Bearings. These bearings increased capacity, performance and bearing life.

BEARING SELECTION GUIDE
A new 140-page Bearing Selection Guide, complete with 30 pages of vital engineering data, has been released by the McGill Manufacturing Co. Ask for Catalog No. 52.

McGILL® — **Precision Bearings**
McGILL MANUFACTURING COMPANY, INC.
201 N. Lafayette Street, Valparaiso, Indiana

Tiny Solenoid Valve



A new four-way solenoid valve is believed to be the smallest (only $4\frac{5}{16}$ in. high) of its type ever marketed.

These valves are leakproof, suitable for air, hydraulic oils and other common media and will operate in any position. One of these units can control one double-acting cylinder or two single-acting cylinders. Some 176 standard variations of capacities, metering and types make these valves suitable for numerous applications.

Three basic types are offered: normally open, normally closed, or combination—normally open and normally closed.

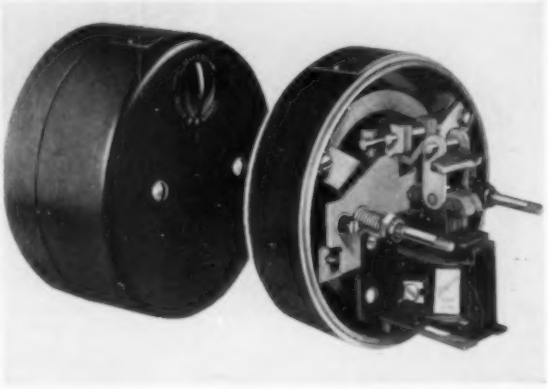
The new valves are packless and frictionless in construction. A direct-acting, springloaded design is said to assure positive action and bubble-tight shut-off at all ports.

Bodies are made of die-cast zinc; internal parts are stainless steel. The NEMA Class coil is varnish-impregnated and highly resistant to moisture.

Pressures range from 0 to 150 psi; orifice diameters from 3/64 to $\frac{1}{8}$ in. This new component is available for all common a-c and d-c voltages. They have a maximum power consumption of 10 w per solenoid, 20 w total.

Skinner Electric Valve Div., Skinner Chuck Co., Edgewood Ave., New Britain, Conn.

Magnetic Brakes for FPH Motors



Two new magnetic disk brakes for fractional horsepower motors are being made. One of them is designed to meet the new NEMA frame standards in the 1/20 hp to 1/3 hp range. It is 5 in. in diameter, less than $3\frac{1}{2}$ in. long and has a torque range of from 6 lb-in. to 1 lb-ft. Designed for mounting on the standard NEMPA C and bell for motor frames 42-C and 48-C, the brake is also available for floor mounting on the standard NEMA C and bell for motor

The other new brake model is designed for re-rated NEMA frames in the 1/6 hp through 2 hp motor range. It is available in four torque ratings: $1\frac{1}{2}$, 3, 6 and 9 lb-ft. This brake is designed to mount on new fractional horsepower motor frames 56-C and 66-C and integral horsepower motor frames 182 and 184. It is said to take less than one-half the space previously required.

Stearns Magnetic, Inc., Milwaukee 46, Wis.

A RELAY capable of operating in previously unobtainable low-power ranges has been introduced. It is reported to operate on input powers of 25 microwatts in standard models or as low as 1 microwatt in special cases. That is why the relay will operate directly from photocell and thermocouple outputs and can be used in plate and grid circuits. Thomas A. Edison, Inc., Instrument Div., West Orange, N. J.

A NEW UNLOADING VALVE for system pressures to 3,000 psi is reported to be easily adjustable and will maintain desired pressure settings. Large internal passages assure maximum flow with minimum pressure loss. No external drain lines are required. Available in two pressure ranges: 500 to 1,500 psi, 1500 to 3000 psi; two pipe sizes, $\frac{3}{8}$ and $\frac{3}{4}$ in. Waterman Engineering Co., 725 Custer Ave., Evanston, Ill.

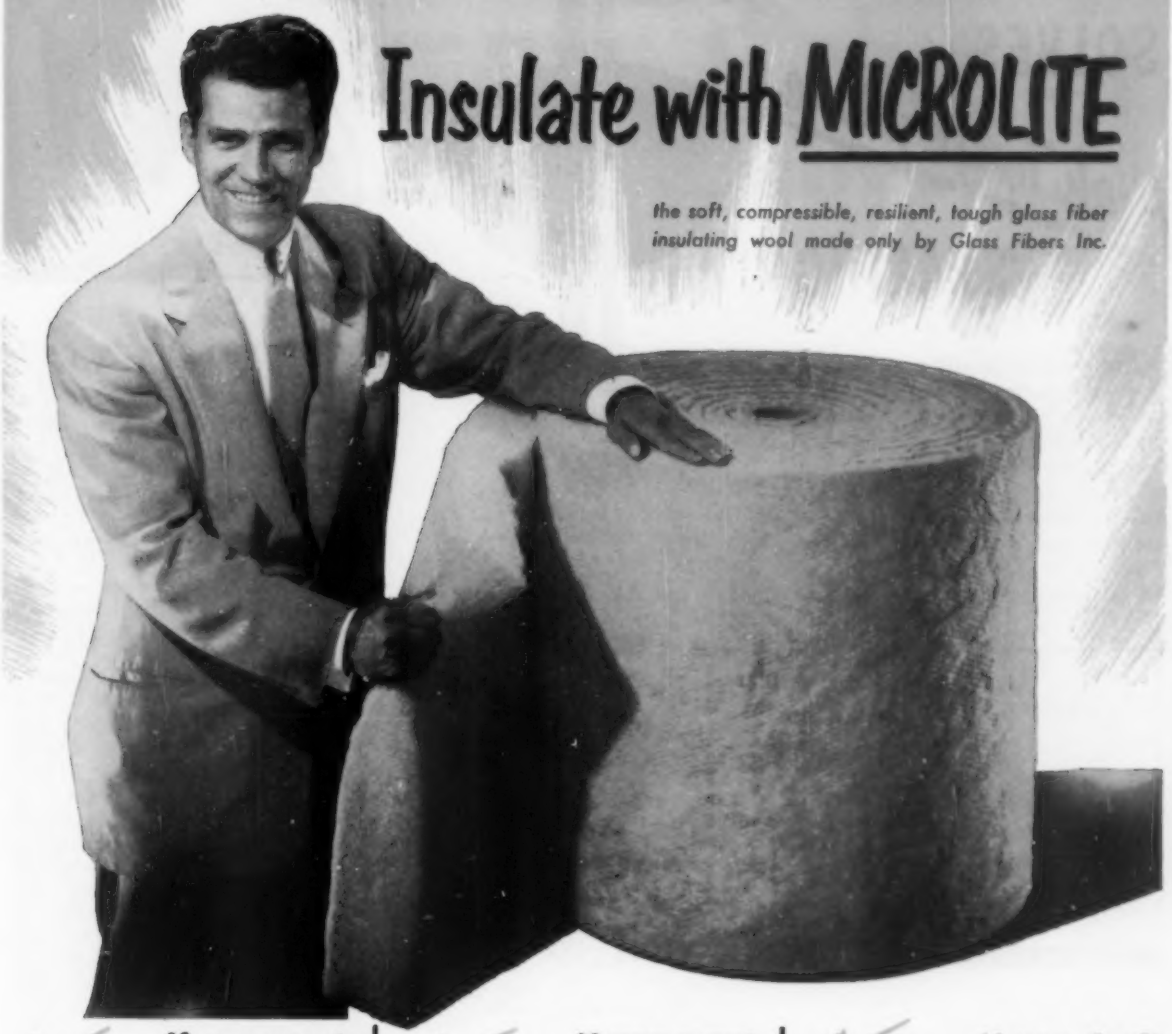
TWO NEW DYNAMOMETERS for measuring electric motors of 2 hp and less have broad-range speed-measuring equipment available as extra accessories. One provides accuracy to 2 percent, the other to 1/10 of 1 percent. Both models of the new dynamometer are supplied with a special d-c power supply. For further information: Mission-Western Engineers, Inc., 132 West Colorado, Pasadena 1, Calif.

CONTINUED ON PAGE 234

If you want to lick these three ever-present problems,

Insulate with MICROLITE

the soft, compressible, resilient, tough glass fiber insulating wool made only by Glass Fibers Inc.



if you want to save space

As an example, half-inch, half-pound density Microlite has a "k" value of .26 at 75° F. mean. If you want the greatest thermal or acoustical efficiency in the smallest space, insulate your product with Microlite. That's what designers of refrigerators, home freezers and house trailer coaches are doing. What's *your* space saving problem?

if you want to save weight

As an example, 24 feet of half-inch, half-pound density Microlite weighs only 8 ounces. If you want the greatest thermal or acoustical efficiency with the least weight, insulate your product with Microlite. That's what designers of refrigerated truck trailers and aircraft are doing. What's *your* weight saving problem?

if you don't want "shake down"

Microlite resists settling when subjected to incessant bumps, jarring and vibration. If you want the greatest thermal or acoustical efficiency with the least possible "shake down" insulate your product with Microlite. That's what designers of buses and railroad cars are doing. What's *your* "shake down" problem?

Folder WB-1 describes briefly but in detail the properties of Microlite glass fiber insulating wool; also contains thermal and acoustical performance tables. Write for your copy now. 1810 Madison Avenue, Toledo 2, Ohio.

GLASS FIBERS INC.

Makers of glass fibers by the ELECTRONIC-EXTRUSION process—developed, patented and used exclusively by Glass Fibers Inc.

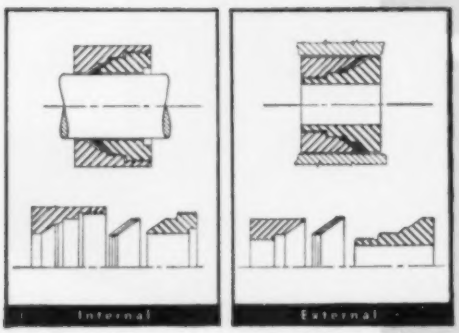
VITRON Yarns • Rovings • Micro-Fibers • Pipe Wraps • Industrial Mats • MICROLITE Thermal and Acoustical Insulation
DURAMAT Vapor Barriers • VIBRAGLASS Mounting and Packaging Materials • COUSTIC-AIRE and THERMO-JET Aircraft Insulations

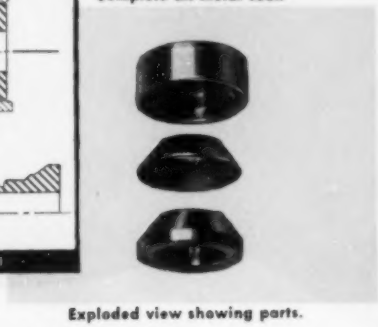
SOLVES *High Temperature* SEALING

• Assurance of positive seal under high temperatures and pressures need no longer be a problem. Sylphon metallic Reed Seals are engineered to meet those conditions efficiently and dependably. They are used successfully in many applications in aircraft, hydraulic systems, Diesel and other engines and in the chemical and other industries.

Sylphon Reed Seal, installed.

Complete all-metal seal.





Exploded view showing parts.

CHECK THESE ADVANTAGES

Wide range of materials. Metallic seals can be made of Inconel "X", Truflex 720, Duranickel, bronze and stainless steel. For lower temperatures, plastic seals used are nylon and Teflon.

Broad temperature range. Typical examples: Inconel "X", -100° F. to 1200° F.; Duranickel, -100° F. to 900° F.; stainless steel, -100°F. to 650°F.

Pressures to 3,000 psi.

Excellent corrosive resistance to many chemicals, aromatic fuels, hydraulic oils, etc.

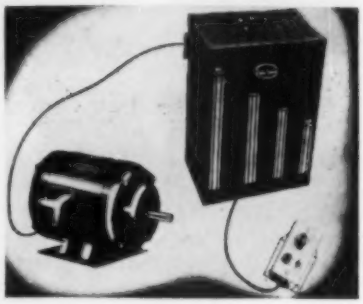
Seal external or internal cylindrical surfaces: also flat seals can seal flanged or parallel surfaces.

No deterioration in stock.

Write today for information. Ask for Bulletin LP-827

Robertshaw-Fulton
CONTROLS COMPANY

FULTON SYLPHON DIVISION • KNOXVILLE 1, TENN.



Variable Speed Motor Control Systems

A completely redesigned line of variable-speed motor control systems, from 1/15 up to and including 3 hp models, now make use of special terminal block transformer construction, special cabinet design for wall or bench mounting and critical component plug-in assemblies.

It is stated that this new electrical design utilizes the motor series field as a torque signal source in a patented feedback circuit to provide constant system torque capability. Controlled acceleration on many models allows use in applications of high inertia loads without placing excessive torque load on materials in critical processes.

Fingertip-controlled models for manual speed selection at remote points are available, as well as a line of automatic systems for use in various industrial operations or processes. Automatic tension control, constant surface speed wind-up, and other such automatic arrangements are available, as well as memory-type systems operating from magnetic tape recorders to follow previously determined time-speed sequences.

Brown Brockmeyer Co., Dayton, Ohio

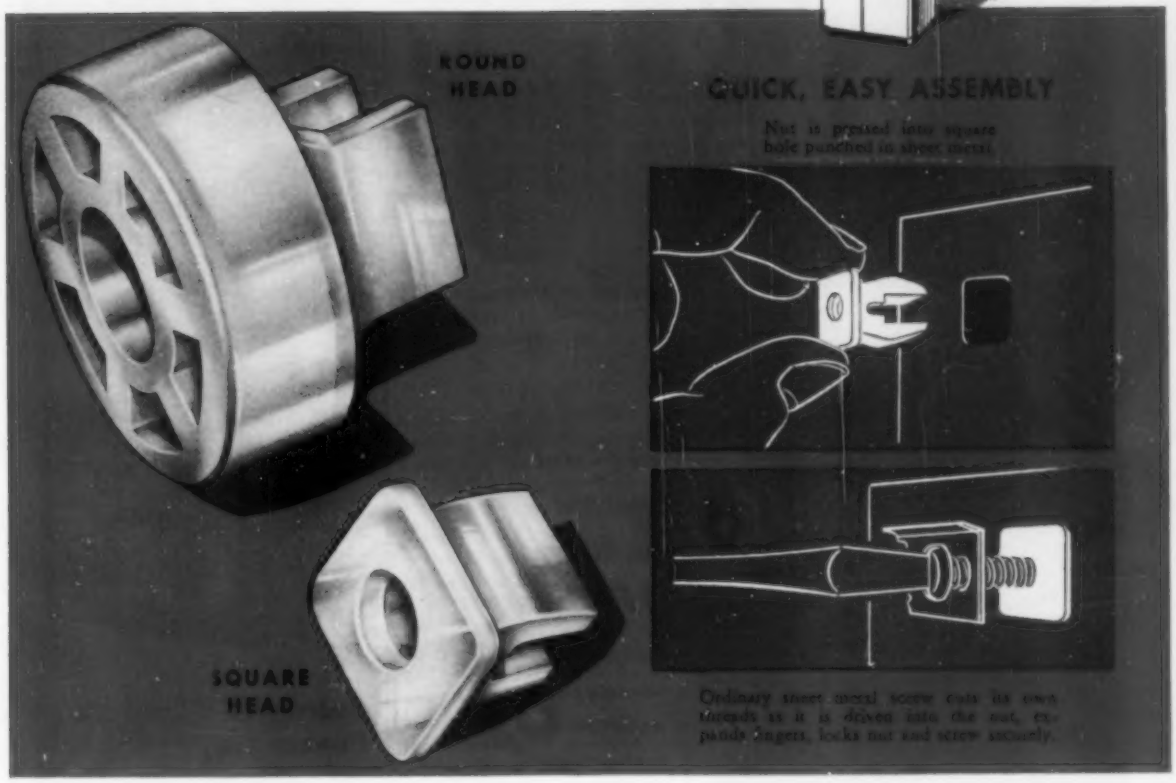
Dual Recording Milliammeter Weighs Only 15½ Pounds

A new ink-writing, recording milliammeter has been developed, using magnetic fluid clutch meter movements. The new recorder takes standard curvilinear chart paper and features two independent channels and four selective chart speeds. The complete recorder occupies less than ½ cu ft and weighs only 15½ pounds.

This small size is said to result from the use of instrument-sized magnetic fluid clutches as the basic component of the meter movements. In each movement, two magnetic fluid clutches rotate in geared opposition, with the

How many ways can **you** use

DOT PLASTIC *snap in* NUTS?


ROUND HEAD
SQUARE HEAD
QUICK, EASY ASSEMBLY
Nut is pressed into square hole punched in sheet metal.
Ordinary sheet metal screw cuts its own threads as it is driven into the nut, expands fingers, locks nut and screw securely.

United-Carr's new self-locking, plastic nut is designed for blind application and can be used with all types of metal finishes without scratching or chipping the surface. Its plastic fingers provide rigid anchorage yet will not mar paint, polished metals or even porcelain.

Inexpensive sheet metal screws cut their own threads and expand the nut's fingers as they are driven, locking both nut and screw tightly in place. Screws can be removed and replaced several times without damage to the nut.

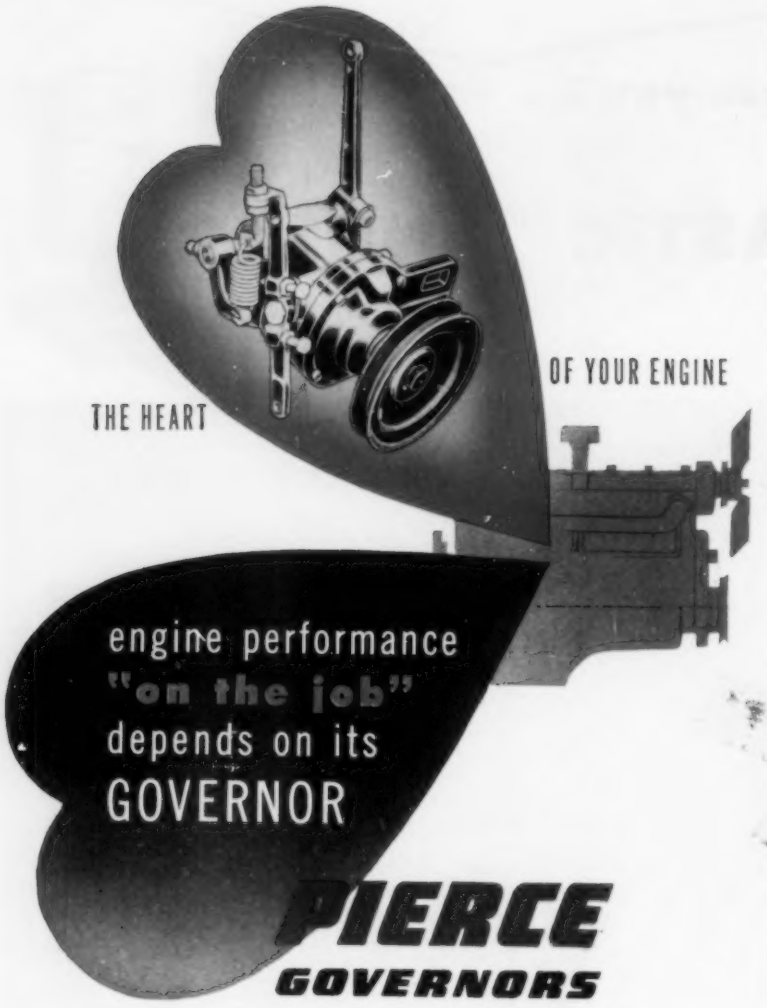
DOT plastic snap-in nuts are electrically non-conductive and provide a high degree of insulation against heat transfer. For all practical purposes, they also provide an effective vapor seal.

Available in several styles and sizes. Write for full information and samples or contact your nearest United-Carr representative.

UNITED-CARR FASTENER CORP.

CAMBRIDGE 42, MASSACHUSETTS

MAKERS OF DOT FASTENERS



PIERCE GOVERNORS

offer you completely dependable governing plus all the advantages of Pierce's 40 years experience in solving design and engineering problems.

Pierce low-cost centrifugal governors are available for gas, gasoline or diesel engines . . . from small generator sets to monster power units. Send full details and specifications on your problem.

"WORLD'S MOST EXPERIENCED GOVERNOR MANUFACTURER"

the PIERCE GOVERNOR COMPANY
INCORPORATED

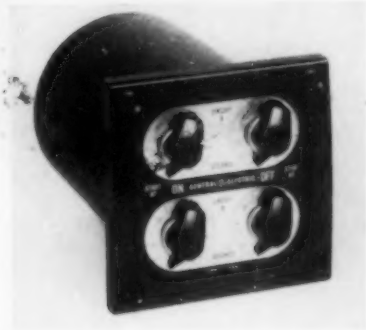
1686 OHIO AVENUE
ANDERSON, INDIANA

recording pen linked to the output shafts and responding to the resultant torques developed.

The new recorder meets the rigid military aircraft requirements for shock, vibration, explosion, and humidity resistance. Corrosion-resistant, durable alloy metal pens are used for both recording and marker timing, with different color inks used on both pens for each channel. Paper is the standard 6 in. curvilinear translucent chart available in 100-ft rolls.

The four selective chart speeds range from 12 in. per hr to 12 in. per min, allowing continuous recording up to 100 hr without reloading. Frequency response is excellent, ranging through 15 cps with an accuracy of 5 percent from dc through 6 cps. Sensitivity is 0.45 in. per 100 microamps, with a linear recording range to 500 microamps. Unidirectional recording is possible to 1 milliamp.

Texas Instrumenst Inc.,
6000 *Lemmon Ave., Dallas 9, Texas*



Redesigned Process Timers

Time-delay opening and closing of electric contacts is accomplished with a redesigned line of process timers. They can control such process equipment as hydraulic presses, tire molds, carpet dryers, baking equipment, heat-treating ovens, sirens, mixing machines, signals, conveyors and photographic equipment.

Features of the redesigned equipment include extra heavy nylon gears, over-all construction of almost 100 percent pure zinc alloys and a dust-resistant cover. New semi-flush mounting on the face of the timers reduces size and streamlines the equipment. An internally engraved connection diagram together with screw-type terminals permit easy wiring.

The timers are available in single-circuit or two-circuit models. Any combination of single and two-circuit

BEFORE YOU DECIDE ON ANY HYDRAULIC PUMP FOR YOUR PRODUCT LOOK OVER THESE

CHECK POINTS OF Pesco SUPERIORITY

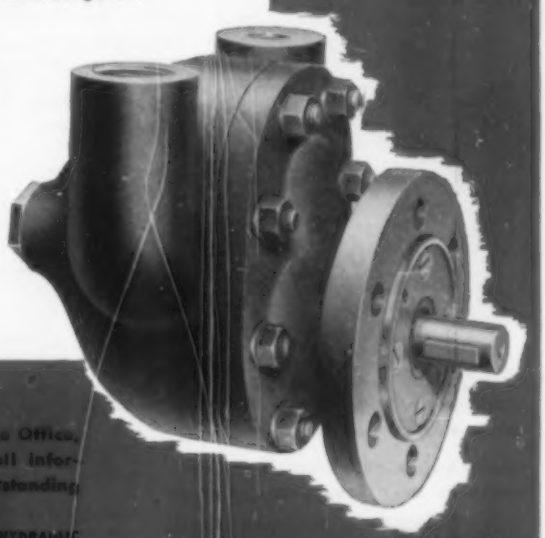
✔ DEPENDABLE PERFORMANCE—Thousands of PESCO Pressure Loaded PUMPS on critical installations, have proved their dependability of operation with exceptional high-efficiency performance of their specific jobs.

✔ CONTINUOUS "NEW PUMP" EFFICIENCY—PESCO quality control, from original design through precision manufacture and final testing, builds into PESCO products every characteristic that will insure life-long, peak-operating efficiency and "new pump" performance—with volumetric efficiencies to 97% and torque efficiencies to 92%.

✔ FULL RANGE OF CAPACITIES AND PRESSURES—PESCO PUMPS provide a full range of capacities to 60 gpm and pressures to 3000 psi. Operating speeds range from 1000 rpm to 4500.

✔ HYDRAULIC ENGINEERING SERVICE—This outstanding PESCO service is available for solution of hydraulic problems. Simply call or write the Home Office, Bedford, Ohio—The combined experience and skill of Pesco Hydraulic engineers is yours without obligation.

✔ LESS UNIT SPACE REQUIRED—The "Pressure Loading" features of PESCO PUMPS reduce the overall size requirement for a given installation. This is possible because PESCO PUMPS can be operated safely at higher speeds—and still maintain the same excellent volumetric efficiencies at slow operating speeds.



Call or write the Home Office, Bedford, Ohio for full information on these outstanding PESCO PRODUCTS.

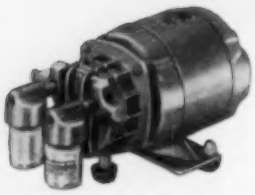
HYDRAULIC PUMPS • HYDRAULIC MOTORS • CONTROLS AND VALVES
POWER PACKAGES • ELECTRIC MOTORS

engineering Pesco production
PRODUCTS DIVISION

PRODUCING THE BEST IN HYDRAULIC EQUIPMENT AND ELECTRIC MOTORS

BORG-WARNER CORPORATION
24700 NORTH MILES ROAD BEDFORD, OHIO

for original equipment vacuum pumps: call on GAST



Integral Motor-pump Model 0406 — To .6 CFM, 25" vacuum. Only 10-1/4" long, weight 16 lbs., 1/12 HP.

YOU GET HIGH QUALITY!

Gast Air Pumps solve many a product problem — with consistently high performance over a long service life. No accident, this results from simple, dependable rotary-vane design, plus rigid quality control in manufacturing. As reliable components, Gast Vacuum Pumps help "win friends" that bring repeat orders for your products.

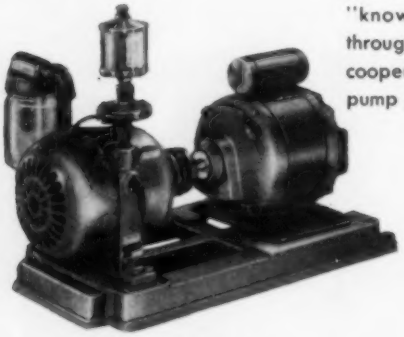
V-belt Model 1550-V2—To 10 CFM, 15" vacuum. Popular for paper feeding, vacuum back cameras, etc. Direct drive also.

A WIDE CHOICE OF SIZES—

Select the pump you need from five basic types — and many sizes — up to 24 CFM, or 28" vacuum. Many are offered with either standard or oil-less construction. Over 200 assembly models are in production — which helps lower your costs!

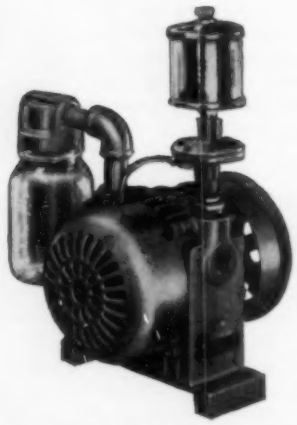
YOU GET FULL COOPERATION

Vacuum pumps for original equipment have been a principal Gast product for over 25 years. So you can tap a wealth of technical "know how" and valuable experience through Gast's engineers. They're ready to cooperate fully in solving your vacuum pump problems, so *call on Gast!*



Heavy-duty, Fan-cooled Model 1065-V4-34. To 28" vacuum with 1/2 HP. With or without base, motor.

Some accessories standard equipment, others available for specific applications.



Heavy-duty, V-belt Model 2565-V-12A. To 28" vacuum, to 21 CFM. Two fans.

Original Equipment Manufacturers for Over 25 Years

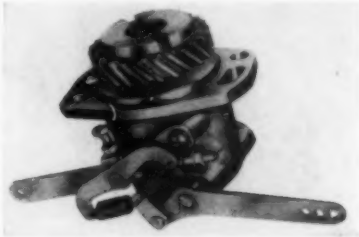
GAST ROTARY — AIR MOTORS • COMPRESSORS • VACUUM PUMPS (TO 3 H.P.) (TO 30 LBS.) (TO 28 INCHES)

GAST MANUFACTURING CORP., 139 Hinkley St., Benton Harbor, Mich.

units can be utilized to control three, four, ten or more circuits. Equipped with a bevel for semi-flush mounting, the timer requires a minimum of mounting facilities as used by all switchboard and control panel manufacturers.

The timer measures $5\frac{3}{4}$ x $5\frac{3}{4}$ x $8\frac{5}{32}$ in. and weighs $6\frac{3}{4}$ lb. It operates on a power supply of 60, 50 or 25 cycles, with a contact rating of 10 amp at 120 v or 5 amp at 240 v.

General Electric Co., Schenectady 5, N. Y.

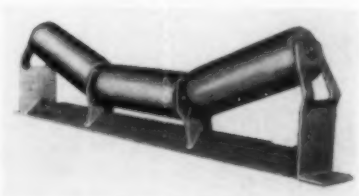


Gear-Driven Mechanical Governor

All government specifications for accuracy of control, recovery and service life are said to be met by a new gear-driven governor. It is stated that the unit's external, two-spring system eliminates the need for a number of governors on the same engine.

Ball bearings are used at all load points. Fly-weights, for example, are equipped with load-easing needle bearings. Oil capacity is said to be great enough to eliminate daily oiling.

Hoof Products Co., 6453 S. Laramie Ave., Chicago 38, Ill.



Ball Bearing Conveyor Carrier Has Spun Ends

This new low cost conveyor belt carrier has rollers with spun ends which turn on precision ball bearings. Die cast labyrinth seals protect bearings and provide permanent protection since they are non-corrosive, according to the manufacturer. "Alemite" fittings are provided for relubrication if desired. However, sufficient grease is said to be contained in the bearing

chambers to operate carrier rolls on a "lubricated-for-life" basis.

Carrier frames are of jig-welded steel construction. Formed steel brackets and inverted angle base are designed to prevent build up of dust and dirt. The 4-in. dia carrier rolls are interchangeable and can be inserted or removed from brackets without tools. An extended lubrication kit is available for lubrication from one side of carrier.

The new carrier is available for stock shipment in sizes for 18, 24, 30 and 36 in. belts.

Stephens-Adamson Mfg. Co., Aurora, Ill.

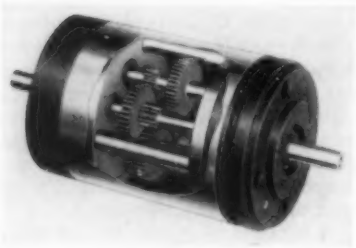
Elastic Coupling

An elastic shaft coupling is being marketed that consists of the two shaft hubs between which are inserted solid neoprene cylinders held in place axially by lockwires.

These cylinders are subject to a combination of shear and compression and provide a maximum of torsional flexibility. Their snubbing characteristics are instrumental in isolating or damping torsional vibration. Replacement of cylinders is extremely simple and inexpensive.

These couplings are available in shaft sizes from ¾ up to 6 in. dia. The larger sizes are said to provide ideal coupling means between internal combustion engines and driven machines.

Odin Corp., P.O. Box 6032, Castleton, Ind.



Miniature Speed Reducers

A new series of precision miniature speed reducers for general laboratory and product use measure 1.062 and 1.687 in. dia, respectively, and 1.656 and 1.859 in. in length, exclusive of shaft length, which can be specified. Ratios range from 12.5 to 10,000:1.

Specifications include backlash of less than half a degree. The smaller unit is designed for output torque loads up to 25 in.-oz; the larger is rated at 100 in.-oz max.

Both units feature ABEC Class 5 ball bearings throughout. Sleeve bearings for gear clusters may be specified,

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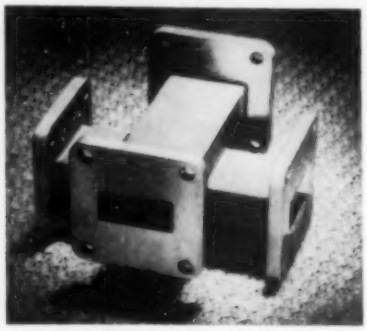
however, where optimum precision is not required for a particular application. Cap assemblies are black anodized aluminum, and housing and bearing plates are corrosion-resistant steel. Gears are cut to AGMA Precision 2 tolerances from stainless steel, or from aluminum bronze where very quiet operation is necessary.

Slip clutches and mounting hangers can be supplied as accessories for either series.

The two new speed reducers are said to be especially applicable for electronic controls, actuators, servos and similar equipment where very small size and weight are vital factors.

Bowmar Instrument Corp.,
2415 *Pennsylvania St., Fort Wayne, Ind.*



Cross Guide Couplers

A new line of directional couplers makes it possible to provide higher minimum directivity over the waveguide band, less coupling variation with frequency and higher breakdown power. The first of these new couplers has the following characteristics: directivity—approximately 22 db or more; coupling accuracy—mean coupling level is within 0.4 db of 30 db; coupling variation—less than 0.6 db over the frequency range.

Additional models in this new series of cross guide couplers for other wave guide sizes and coupling values will soon be available.

Microwave Development Laboratories, Inc.
220 *Grove St., Waltham* 54, *Mass.*

Series or Shunt Motor

A new series motor is also available as a shunt motor. The series design provides $\frac{1}{8}$ hp on intermittent service; $\frac{1}{10}$ hp on continuous. Shunt model; $\frac{1}{6}$ hp, intermittent; $\frac{1}{12}$ hp, continuous.

The unit is die cast and is reported to be held to very close tolerances. Housing is ribbed for greater strength. Either porous bronze self-aligning

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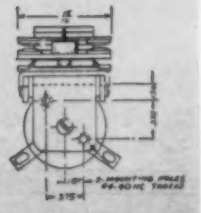
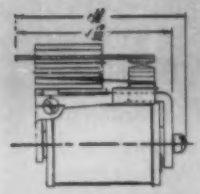
SMALL, LIGHT SENSITIVE


END VIEW

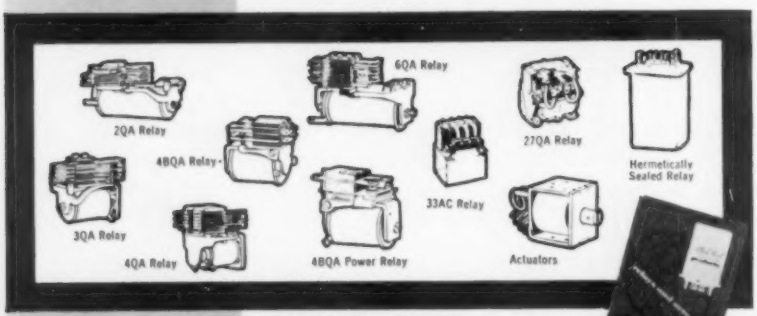

SIDE VIEW

Among the wide variety of *Standard* Phil-Trol Relays you will find many designed to solve your "special" problems . . . like the types 4BQA and 4BQA POWER shown above. While both are small, compact, lightweight units, each is designed to perform its job best. For example:

The 4BQA Multi-contact D.C. is used where very sensitive or marginal operate and release factors are required. This relay may be provided in multi-contact combinations with as many as 12 contacts.

The 4BQA Power Type D.C. has the capacity to handle large currents on the contacts. Standard contacts are rated at 25 amperes.

These are but two of the many unusual Phil-Trol designed relays that will help you solve the "tough" application problems as well as the simpler ones . . . and with security in knowing you will always have dependable performance. Send for a new Phil-Trol Catalog — today!



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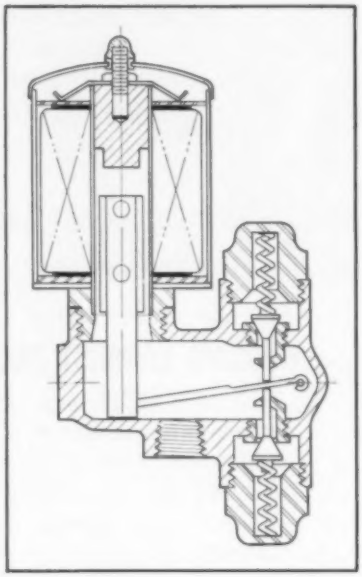
sleeve bearings with oversize felt oil reservoir or precision, grease-sealed ball bearings are available. The new motor is made in both open and closed styles. Internal fan is optional.

Other optional features: 10 different gear units with a wide range of ratios; automatic governor control for two speed, single speed or adjustable speed; automatic or manual motor protector that can be built into housing. Motor can be mounted on base or face mounted.

Typical applications expected for the new motor include movie projectors, radar equipment, railroad signaling devices, watchmaker's lathes, coin operated vending machines and control mechanisms.

Howard Industries, Inc., Racine, Wis.



Solenoid Valves For Hot, Corrosive Service

A new line of three-way solenoid valves is now available, with either steel or stainless steel bodies. They have stainless steel trim throughout and are designed to handle a wide variety of gases and liquids usually corrosive to bronze, brass and cast iron.

When equipped with high temperature coils, these valves will also handle gases to 450 F. A water-tight and explosion-proof solenoid enclosure is available on special order. These valves are "packless", having no sliding glands or stuffing boxes. Direct solenoid operation with a force-multiplying lever assures reliable operation.

Valves of this type are frequently employed for pilot control of dia-

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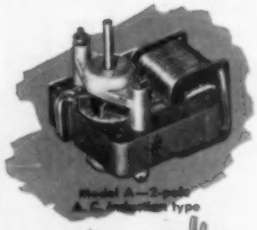
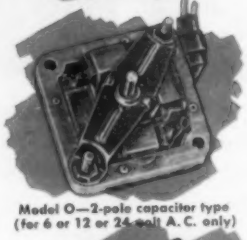
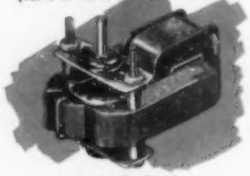


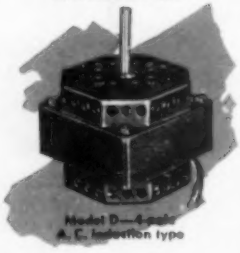
Model A—2-pole A.C. induction type



Model O—2-pole capacitor type (for 6 or 12 or 24-volt A.C. only)



Model C—2-pole A.C. induction type



Model D—4-pole A.C. induction type

These dependable small motors are designed and built to provide years of trouble-free service in all types of small-load applications.

Thousands of these compact power units already in use are delivering full-rated power and long life at low original cost and low operating cost.

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phragms and for applying and exhausting pressure from single or double acting cylinders. They are used for direct control in chemical processing applications to divert and select flow from one or two pipe lines, and find important applications in refinery-type service. They are "factory set" for desired flow conditions.

Pipe size with which the valve is to be used is one inch. Port orifices are five in number, $\frac{1}{8}$ to $\frac{3}{8}$ in. Maximum pressure, 1,000 psi.

Automatic Switch Co.,
391 *Lakeside Ave., Orange, N. J.*

Faster Digital Tape Handler

A new digital tape handler is said to have start and stop times of 5 milliseconds and tape speeds up to 60 in. per sec. Extension of available tape width to $\frac{5}{8}$ in. permits up to eight channels of information to be recorded simultaneously. This tape is completely interchangeable from one machine to another.

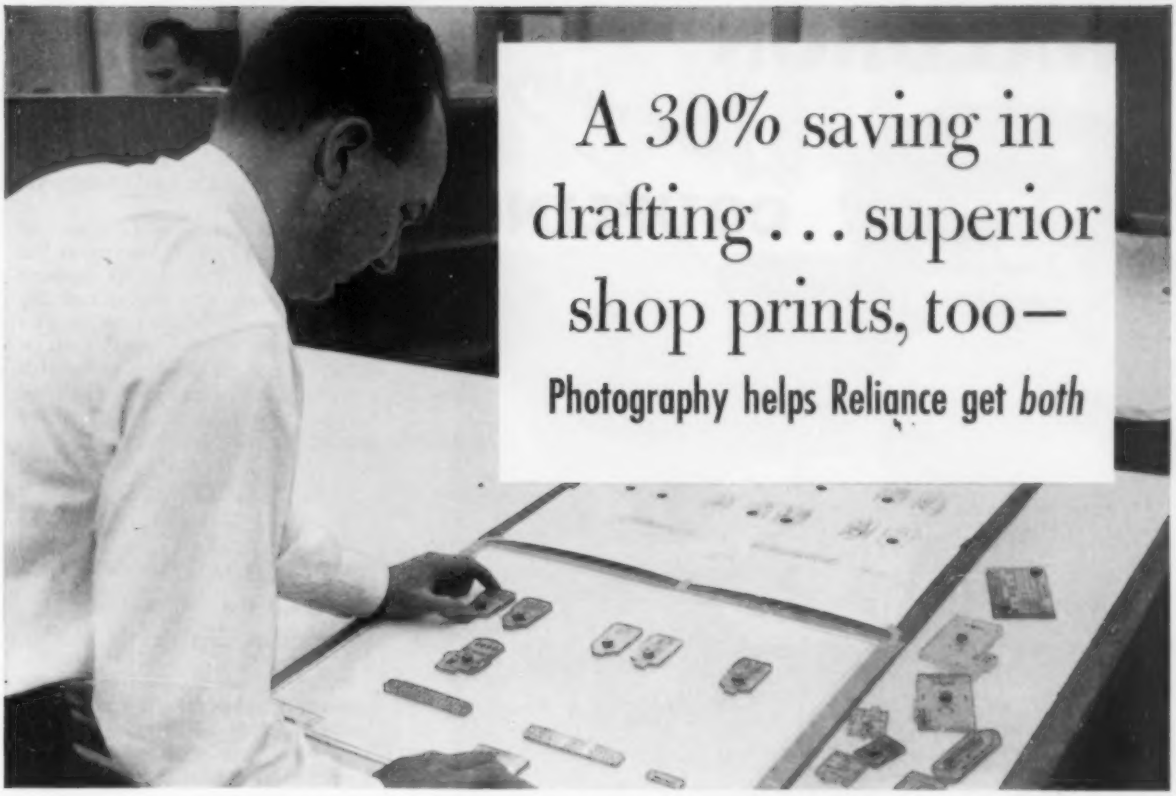
Servo-controlled reel drive systems are reported to ensure lower tape tensions for longer recording head life and longer tape life in spite of high acceleration and deceleration. The new models features a head-azimuth adjustment. Standard 19-in. rack mounting is used. Power requirements are 400 w at 115 v, 60 cps.

Potter Instrument Co., Inc.,
115 *Cutter Mill Road, Great Neck, N. Y.*

Wire-Wound Potentiometer

This wire-wound potentiometer is said to be especially useful for slow circular sweep on oscilliscopes or for low-frequency sine-wave generation. Two output voltages are provided, accurately proportional to the sine and cosine of the angle of shaft rotation. Both a sine-wave and a cosine-wave voltage output are given.

The new potentiometer is precision constructed, with ball bearings, pre-



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Photography helps Reliance get *both*

At the Reliance Electric & Engineering Co., Cleveland, Ohio, the use of photographic templates and Kodagraph Autopositive Paper has helped to lower drafting-room costs by at least 30%, besides assuring highly legible shop prints day in and day out.

The templates—on clear plastic—represent the designs of standard components that appear again and again in Reliance's many wiring diagrams. A draftsman uses them, first, to make a preliminary drawing – positioning the templates he needs on whiteprint paper, making a print, then roughing in the hook-up lines.

After this drawing has been approved, he prints the templates on Kodagraph Autopositive Paper, using a printing frame. Simple photographic processing—under normal roomlight—produces a positive print of the layout directly. All he has to do now is add the hook-up lines, and another drawing is ready for Reliance's file of photo-lasting Autopositive "originals." *Another saving can be chalked up!*

Reliance has found these photo-drawings to be ideal printing intermediates. They're evenly translucent, durable; have crisp, dense black lines. And they produce top-quality shop prints at practical, uniform speeds in Reliance's direct-process machine.

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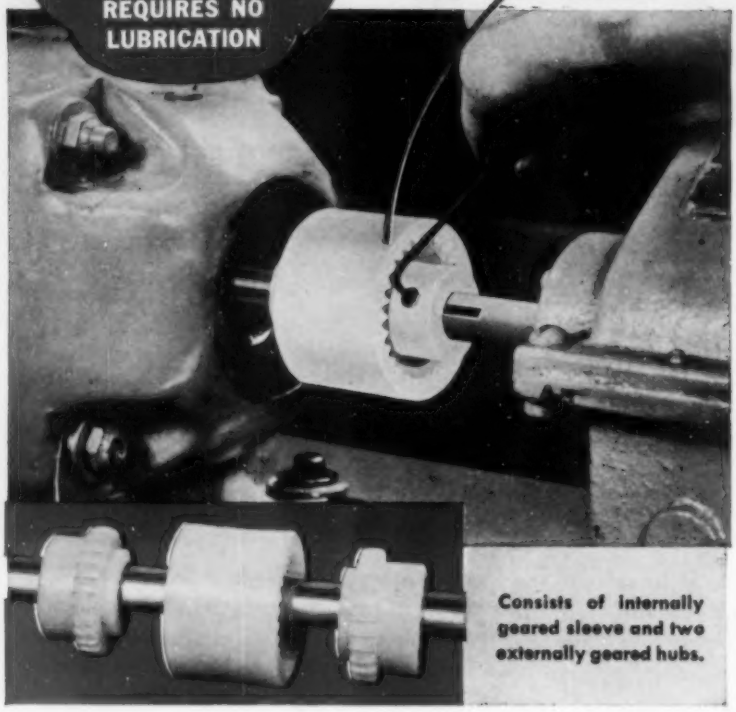

Consists of internally geared sleeve and two externally geared hubs.

weighs 2¼ oz. . . . resists wear

Made of smooth, tough, durable nylon, this new WALDRON "Junior" Coupling provides many operating advantages and economies for smaller fractional H.P. drives.

Non-magnetic and non-corrosive, it is not affected by water, oils, most common chemicals and gases.

Because it requires no lubrication and has nothing to wear out, it is the most economical coupling you can use for longer service without maintenance or repairs.

Available in ⅜"—½"—⅝"—¾" nominal bores.

Write for full particulars, dimension tables, test data, etc.

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cious metal contacts and silver slip rings. It has a 360° continuous mechanical rotation, standard winding resistance is 16,000 ohms (10 percent), rating is 1.5 w at 65 C, and life expectancy is said to be 350,000 revolutions, minimum.

The output wave is pure sine or cosine, with an average deviation less than 0.5 percent. Its over-all diameter is $2\frac{3}{8}$ in., with a case diameter of $2\frac{5}{16}$ in. The mounting shoulder is $\frac{3}{4}$-in. dia and the stainless steel shaft is $\frac{3}{4}\frac{5}{6}$-in. long. All insulating materials are treated with fungicide varnish and the aluminum flange is anodized against salt-spray corrosion.

Rawson Electrical Instrument Co., 110 Potter St., Cambridge, Mass.

Relief Valves For 2000 Psi Hydraulic Circuits

Relief valves designed to fill the growing demands for efficient pressure control in 2000 psi hydraulic circuits have been introduced by a designer and manufacturer of hydraulic presses and components.

According to the announcement, these new valves are economy priced, yet retain many of the operating benefits of the same maker's 5000 psi valves.

The new units are light and compact in construction and are furnished with threaded bodies for in-the-line or "tee'd" connections. They are available in pipe sizes of ½, ¾, 1¼ and 1½ in. and may be vented or operated by remote control.

Pressure regulation from 100 to 2000 psi is available in the ½, ¾ and 1¼ in. sizes. Pressure settings from 150 to 2000 psi are possible in the 1½ in. size.

These new 2000 psi relief valves can also be used as safety valves for volumes greater than their rated capacities.

The Denison Engineering Co., Columbus, O.

New Cylinders Designed For Automation Equipment

New air cylinders are said to be especially suited for automation applications as well as for general use on conveyors, dies, machine tools, presses and welding machinery. It is stated that they also meet the difficult requirements of foundry, oil field and steel mill equipment.

The new cylinders are made in five

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2-Way Solenoid Valve
for controlling the flow
of Air, Gas, Light Oil,
Water, Brine, Freon,
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BULLETIN 8210A
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shown approximate size

Pipe sizes —
3/8" and 1/2"

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Featuring:

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  3 1/4" Pipe center line to top of Solenoid.
  3 13/16" Overall Height.
- **Simplicity** — Only two operating parts: flexible diaphragm and stainless steel core.
- **Ruggedness** — Designed for millions of maintenance free operations.
- **Forged Brass Body and Bonnet** insure freedom from porosity.
- **No Corrosion Problems** — All parts in contact with fluids are of brass or stainless steel.
- **Normally Open or Normally Closed** Types Available.
- **Low Power Consumption** — Only 10 Watts!
- **No Jamming or Binding** — No closely fitted parts that can be jammed by solid matter.
- **Nema I Standard or Nema VII** Explosion-Proof Solenoid enclosures.
- **Over Two Years** under Development and Life Test!

THIS NEW BULLETIN 8210A SOLENOID VALVE IS ONE OF THOUSANDS OF TYPES & SIZES IN OUR STANDARD LINE.

WRITE FOR COMPLETE INFORMATION
We design and manufacture a complete line of Solenoid Valves and Electromagnetic Controls including Automatic Transfer Switches, Remote Control Switches, Contactors, Relays, and Complete Control Panels.

ASCO Solenoid VALVES

Automatic Switch Co.

385 LAKESIDE AVENUE · ORANGE, NEW JERSEY

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MACHINE SCREW
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fastenings
SPECIAL WIRE FORM
TAPPING SCREW
AUTOMATIC SCREW MACHINE PRODUCT
Blake & Johnson is headquarters for patented Twin-Fast® twin-thread wood screws now available with Phillips head as well as slotted round, flat and oval heads — in brass and steel, bright finished — in all standard lengths and diameters and some special sizes; others to order.
The complete line of Blake & Johnson fastenings includes machine screws, stove bolts, tapping screws, special headed products, nuts, rivets, chaplets, wire forms, and automatic screw machine products . . . in steel, brass and other alloy metals.
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SINCE 1849
WATERVILLE 48, CONNECTICUT

types of mountings and in eight bore sizes from $1\frac{1}{2}$ through 6 inch.

They are designed to operate at pressures up to 200 psi. They are reported to have a unique cartridge-type rod packing and bearing, which makes possible a quick change of packing with minimum downtime.

Additional features of the new automation cylinders include extra large, hardened piston rods, double porting for extreme high speeds, extra long cushions, interchangeable check and cushion adjustment valves, rolled steel end plates. The design provides minimum mounting and envelope dimensions.

The S-P Mfg. Corp.,
12415 Euclid Ave., Cleveland 6, Ohio

Miniature Permanent-Magnet Motor

Rated at 1/400 hp with operating rotor speed of 10,500 rpm, this new miniature, permanent-magnet motor is suggested for application to small fans, blowers, and other similar light duty applications. Designed for continuous duty, this motor draws 0.18 amp at 27 v d-c and has a total weight of 5 oz.

Dimensions are $1\frac{3}{16}$ in. long by $1\frac{1}{8}$ in dia. The $\frac{1}{8}$ in. dia shaft has an extension length of $1\frac{1}{16}$ in. However, other lengths and special arrangements including splines, keyways, gears can be provided where required. Electrical connections (integral-lead type illustrated) can be provided in a number of arrangements to suit application requirements.

Dalmotor Co., 1375 Clay St., Santa Clara, Calif.

Wiring Template

This template, now available for general distribution, permits the rapid drawing of electronic symbols conforming to specification JAN-STD-15. The sizes of the symbols are in multiples of 0.2 in., standard to the

ELECTRICAL
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KEEP YOUR APPLIANCES
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MANUFACTURERS AND SERVICE MEN WHOSE PRODUCTS SERVE BEST
Specify Belden
WIREMAKER FOR INDUSTRY

for control of

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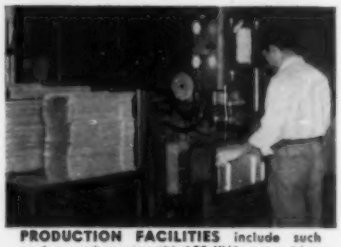
BARRY B MOUNT

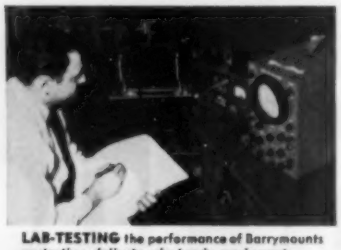
They're YOUR designers - but WE pay them.

You don't have shock and vibration problems every day — but when you *do*, you want them solved promptly. So you want the practical experience of men who've been spending *all* their time in this highly specialized engineering — men who have most likely met and successfully answered questions just like the ones that are bothering you. These men are Barry engineers — ready and able to analyze *your* shock and vibration problems, backed by a laboratory staffed and equipped to *prove* their solutions, and served by model shops geared to produce *your* prototypes whenever you need them.

You'll save time, money, and trouble by using our design and prototype service. Write today for Bulletin DP-54 "This is Barry".



PRODUCTION FACILITIES include such modern equipment as this 100 KVA spot welder, accurately timed for welding aluminum.



LAB-TESTING the performance of Barrymounts protecting delicate electronic equipment.

THE BARRY CORP.

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WATERTOWN 72, MASS.

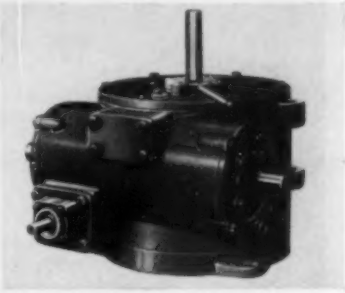
SALES REPRESENTATIVES IN ALL PRINCIPAL CITIES

minimum line spacing allowed under JAN-StD-15.

The straight edges, circles, corners, etc., of the new device allow it to be used as a general electronic template in addition to its specialized use in wiring diagrams.

Made of 0.030 in. matte finish plastic, all cut-outs are milled, not punched, for precision smoothness. Overall size of the template is 7 x 6⅛ inches.

Rapidesign, Inc., P.O. Box 592, Glendale, Calif.



Cam-Operated Indexing Unit

Development of a new cam-operated indexing unit that is said to be able to reduce machine design time as much as 50 percent has been announced. Increments of either 8, 12, 16 or 20 can be obtained during a complete cycle. Positioning for such operations as milling, drilling, soldering, crimping or assembly, is provided at each index position.

Worm and gear connections to the input shaft, drive the cylindrical cam which in turn imparts motion to the indexing table. All rotating shafts are mounted on tapered roller bearings to insure accuracy of all motions. Cam shaft extensions provide a means for operation of auxiliary drives or other production devices. Dimensions: 17 in. long, 16½ in. wide, 13¾ in. high.

Standard Tool & Manufacturing Co., 740 Schuyler Ave., Lyndhurst, N. J.

Pressure Transmitter Provides Positive Seal

This new pressure transmitter is said to provide a positive seal between the gaging system and the fluid measured, and can be used with practically any fluid, including many that would otherwise be dangerous or difficult to measure.

The new unit has a diaphragm that is exposed to the fluid to be measured. The pressure of the fluid on the outer

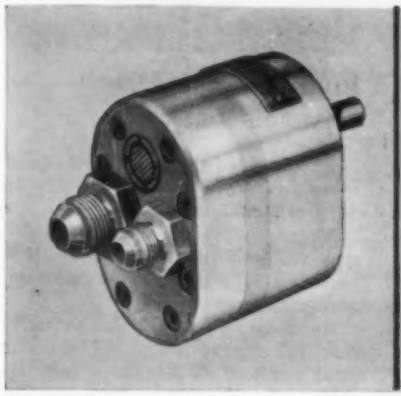
specify with confidence...

HYDRAULIC PUMPS FLUID MOTORS

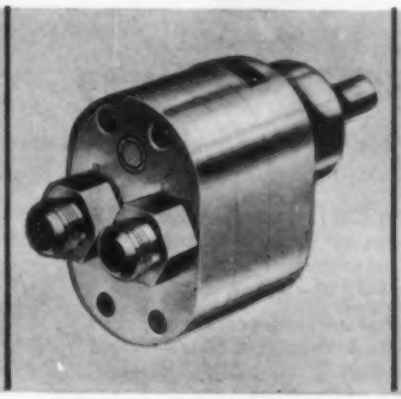
Design engineers have confidence when they specify dependable Eastern Hydraulic Pumps and Fluid Motors. Exclusive Eastern features create an economical, reliable, and compact unit for the heart of your hydraulic mechanism.

Lightweight construction of aluminum alloy housing, nitralloy gears and shaft, and close tolerances assure longer service, higher volumetric efficiency, and more dependable operation. Various types of mountings are available for space saving installation.

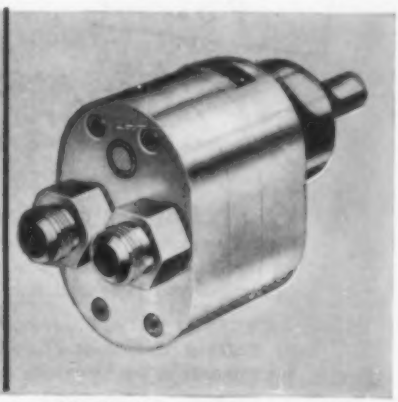
In many cases by specifying an Eastern unit you realize dollar savings as well as great savings in size. They cut operating costs by keeping space requirements and weight to a minimum.



100 Series — Heavy duty gear pump. Delivery from .1 to 5 gpm and working pressures up to 1,500



700 Series — High pressure gear pump. Delivery from .6 to 9.6 gpm and pressures up to 1,500 psi.



2700 Series — Gear type fluid motor. Torque output — 0 to 1[illegible] ft. pounds.

Send for Eastern Hydraulic Catalog 1-800. Contains valuable engineering diagrams and information.

Eastern INDUSTRIES, INC.

296 ELM ST., NEW HAVEN, CONN.

A High Pressure Pump at a Low Pressure Price!

- **COMPLETE HYDRAULIC BALANCE . . . the exclusive DUAL-VANE Design provides and assures complete balance of all hydraulic pressure loads. You get continuous, maintenance-free operation with increased efficiency at all pressures.**
- **INCREASED OUTPUT . . . machine efficiencies can be increased by 2000 psi pump operation without change of other standard components in the hydraulic system.**
- **CARTRIDGE CONSTRUCTION . . . all pumping parts that move are contained within an easy-to-install cartridge. Pump output can be altered by changing cartridge; servicing is simplified and machine down-time reduced.**
- **ECONOMY . . . the low initial cost and the 2000 psi premium performance of DUDCO PF-100 Pumps can double the value of your *hydraulic dollar.***

Write for DUDCO Bulletin No. DP-302. You'll get the facts on the new PF-100 Series Pumps.

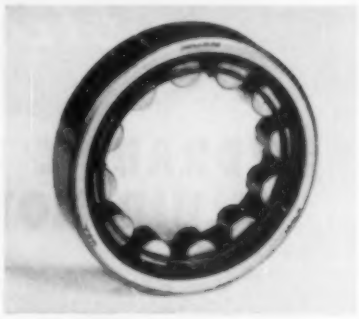
DUDCO DIVISION
THE NEW YORK AIR BRAKE COMPANY
1712 EAST NINE MILE ROAD • HAZEL PARK • MICH.

side of the diaphragm is continuously balanced by the pressure of the air on the inner side; and this pressure is transmitted through a tube to the receiver. The air in the pressure transmitter has no contact with the fluid measured.

Various types of receivers can be used, such as hydrostatic gages, manometers, and pneumatically-actuated recorders or controllers. Two or more receivers can be used with the same transmitter, at different locations if desired.

This is essentially a 1-to-1 transmitter and has linear response from ½ in. water upward. It permits accurate readings at all pressures to 20 psi in vented tanks, and to 45 psi in pressurized tanks. It withstands overpressures of 250 psi without damage.

King Engineering Corp., Box 540, Ann Arbor, Mich.



Roller Bearing Has Separable Inner Race

This general-duty, low-cost roller bearing is now available with or without a separable inner race.

Manufactured to conform with standard SAE bearing sizes, the new bearing is a self-contained roller assembly in an outer race.

Its assembly consists of an outer race, roller retainer and rollers. The inner diameter of the outer race has deep, accurately machined ring grooves. Heavy, substantial L-section snap rings fit into these ring grooves, holding in place the roller retainer and rollers. The roller retainer is a one-piece steel pattern, having pockets with broad double flanges. These keep the rollers in alignment and distribute lubricants evenly.

Depending upon the application required, either the model with or the one without the separable inner race bearing can be used. If the inner race is not used, however, the shaft that replaces the inner race must possess identical finish and hardness charac-NCP&M—51

WANTED

AN ENGINEER—

who is having trouble working out a problem involving hydraulics.

This message takes only two minutes to read but may save you endless hours of hard work.

You know that the functions that play so important a part in any new mechanism are almost never outside the realm of someone else's thought or experience. Whether it be a servo-mechanism, a distinctive type of traction drive, an unusual motion or sequence of operations, the probability is: Hydreco engineers have either rubbed shoulders with the problem or actually worked it out!

Endless hours of concentration in finding the answer is hardly a virtue — if a simpler, more direct, proven solution is to be had. Management may admire long, studied application to a project, but appreciates a quick result much more.

Hydreco engineers, with years of intimate contact with all manner of problems involving hydraulics, represent a rich reservoir of factual information, experience and "savvy." They'll share it with you without cost or obligation on your part. Many of the products of America's top manufacturers are the result of such cooperation. There are many others which are simply project numbers today.

So, if you are stymied, puzzled or just need a fresh approach, write today.

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Without cost or obligation of any sort, I would like to discuss a problem in confidence with a Hydreco engineer.

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Check Standard's Complete Range of tube and pipe sizes!

Whether it's for a pressure, mechanical, sanitary or ornamental use — Standard offers you a convenient "one source" answer to your welded Stainless Steel Tubing need.

TUBE SIZES: ¼" to 4" OD .025 to .148

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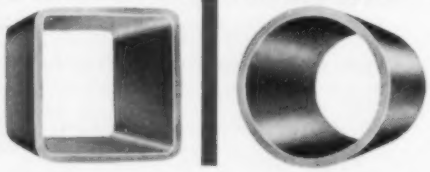

PIPE SIZES: ⅛" to 4" IPS Schedules 5 & 10

Send for Stainless Folder! Our engineers will gladly assist you in your selection of the tube best suited to your needs! Write today!

Specify Standard for

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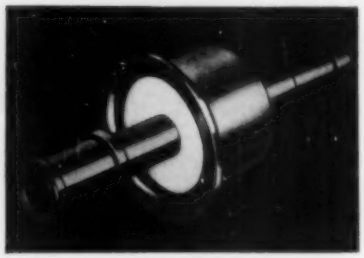
- BOILER AND HEAT EXCHANGER TUBING
- EXCLUSIVE "RIGIDIZED" PATTERNS

teristics. Also, if it is not practical to treat the shaft to a Rockwell hardness of 56 to 60, the hardness range at which the bearing attains maximum capacity, then whatever hardness the shaft possesses governs the bearing's actual capacity.

Rollway Bearing Co., Inc., 542 Seymour St., Syracuse, N. Y.



Hermetically Sealed Terminal

A new kind of hermetically sealed terminal for mounting either by solder or clip is now offered. The new terminal is available in either feed-through or stand-off models for 0.250-in. punched holes. Design is ceramic-to-metal, with leakage resistance after water immersion greater than 10,000 megohms, voltage rating (sea level) of 1,500 volts rms, and a terminal-to-ring capacity of less than 2.5 micro-microfarads.

Metal parts of the terminal are of low carbon cold-rolled steel or brass, electroplated with tin. The terminals are built to withstand failure forces in excess of 150 lb, thermal change from —110 to 212 F.

Feed-through and stand-off terminals are available from stock in small and large quantities, with and without clips. Quantities of 10,000 or less are normally delivered within 10 days to two weeks.

Bennett Products Mfg. Co., P. O. Box 1055, Palo Alto, Calif.

Tolerances of 0.0001 In. Now Possible on Large Ceramic Cylinders

Precision cylinders of the hardest ceramics up to 30 in. length and 6 in. dia can now be produced, with tolerances of 0.0001 in. Ceramic cylinders in these sizes have previously been considered impractical or uneconomical, particularly in the extremely hard alumina or titania ceramics.

Grinding techniques, employing a

(*Advertisement*)

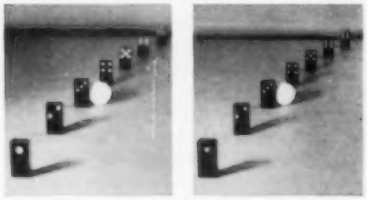
Plain Pointers on Projection

ONE of the claims we make concerning the Kodak Contour Projector is that once an object is brought into focus at any given magnification it will remain in focus when magnification is changed. (This freedom to change magnification is made possible through the use of a lens turret, mounting six lenses, and speeds inspection procedures.) An operator only need flick a dial to switch from one magnification to another; no time is lost refocusing.

Occasionally, however, one of our customers writes to question our claim and declares that he has found it necessary to refocus when changing magnification. This does not upset us. Almost invariably the difficulty can be traced to the phenomenon of optics called "depth of field." This refers to the distance between the nearest and farthest points sharply defined by a lens and is aptly illustrated by the picture below. It is apparent that when a lens is focused on one object, other objects—nearer and farther from the lens—may appear in acceptable focus.

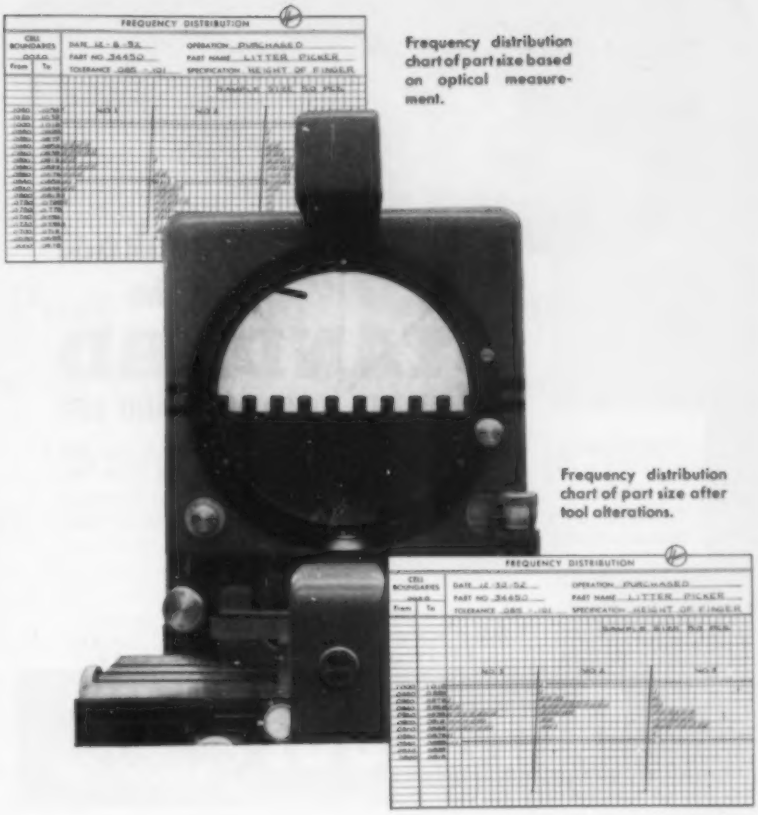
One of the characteristics of this phenomenon of depth of field is that it decreases sharply as magnification is increased. This is equally true when a lens is focused on an actual object, as with a camera, or on an image of that object, as is the case with our contour projector. The result is that when working at higher magnifications depth of field is considerably less than when working at lower powers.

Consequently, it is possible that an object in focus at 10 power may appear out of focus when magnification is changed to 100 power, where depth of field is less and the need for precise focusing correspondingly



greater. Because of this, we recommend that, when inspecting parts at several magnifications, the part first be focused at the highest magnification to be used. This insures focusing within the narrowest tolerances and, when magnification is changed to a lower power, the part remains in sharp focus on the screen. When this recommendation is followed, complaints on the need for refocusing vanish.

Incidentally, it should be mentioned that neither focus nor depth of field affects accuracy of magnification with the Kodak Contour Projector. This remains as rated irrespective of the precision of focus, thanks to what our optical people call a telecentric stop. Which, in itself, is subject for another in this series of columns.



Frequency distribution chart of part size based on optical measurement.

Frequency distribution chart of part size after tool alterations.

Saved...296 pieces per thousand!

Like many another manufacturer, the Hoover Company, Canton, Ohio, has its rejection problems. A typical one involved a flexible, rubber-like "litter picker" used in its vacuum cleaners. Although tolerances ranged from .085" to .101", rejects ran as high as 30%.

To solve this problem, Hoover employed a Kodak Contour Projector to measure the parts, plotted results in accordance with modern methods of statistical quality control. Based on these studies, alterations were made in the cutting tool and the holding fixture for the part. Rejects dropped from 30% to less than ¼ of 1%. Savings amounted to 296 pieces per thousand.

"Optical gaging with the Kodak Contour Projector," say Hoover engineers, *"eliminated incorrect readings caused by mechanical distortion of the parts. In addition, optical methods of measurement proved from 4 to 5 times faster than conventional gaging techniques."*

Your own production measurement or inspection problem may similarly be solved by optical gaging with a Kodak Contour Projector. To find out more about it, send the coupon for your copy of "The Kodak Contour Projector."

15

EASTMAN KODAK COMPANY
Special Products Sales Division, Rochester 4, N. Y.

Please send me a copy of your booklet, "The Kodak Contour Projector."

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PRODUCT ENGINEERING NEWS

PROPERTY AND APPLICATION DATA ON THESE VERSATILE ENGINEERING MATERIALS: "ZYTEL," "ALATHON," "TEFLON," "LUCITE."

NO. 3 — 1954

Both plunger and barrel of 2cc hypodermic syringe are molded of Du Pont "Zytel" nylon. These parts are tough, unbreakable, and can be sterilized with dry heat, by boiling, or autoclaving. Syringe is manufactured by Nelson Products Company, of Arlington, New Jersey.

Investigate Du Pont engineering materials in your product development programs

ONE OF the family of these versatile engineering materials is often a key factor in product improvement or new product design.

The wide range of properties available with "Alathon"* polyethylene resin, "Lucite"* acrylic resin, "Teflon"* tetrafluoroethylene resin, and "Zytel"* nylon resin are helping solve industrial design problems.

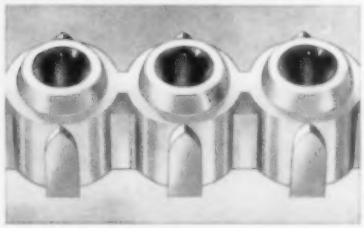
NEED MORE INFORMATION?

CLIP THE COUPON for additional data on the properties and applications of these Du Pont engineering materials.

Battery sealers of Du Pont "Alathon" fit tightly, won't corrode

THE Electric Storage Battery Company, of Philadelphia, Pa., uses positive-plate tube sealers of Du Pont "Alathon" polyethylene resin for the Exide-Ironclad battery. Molded "Alathon" and its versatile properties have effectively lengthened the working life and improved the performance of this industrial battery.

Du Pont "Alathon" is resilient, assuring a tight fit where the sealers cap the plates. Because "Alathon" resists electrolyte and electrolytic action, these battery sealers reduce loss of active material and effectively lengthen battery life. And non-corrosive "Alathon" insulates the plate bottoms, preventing short circuits.



These intricately shaped sealers of Du Pont "Alathon" polyethylene resin are rapidly mass-produced by means of injection molding.

Be sure to evaluate the versatile combination of electrical, mechanical, and chemical properties of Du Pont "Alathon" polyethylene resin. These properties may help solve your own design problems. For more information, clip the coupon below.

POINTERS ON PROCESSING

Injection molding is efficient and economical

INJECTION molding, as a method of mass-producing parts made of Du Pont engineering resin materials, has been developed mainly within the past ten or fifteen years. Improved techniques have accompanied that development.

Injection molding offers the advantages of high production rates, low unit cost, and usually does away with finishing operations. One important saving which has been effected by injection molding occurs when the molded piece replaces an assembly of parts.

High Production Rate. Multi-cavity dies have been made which produce hundreds of identical pieces at a time. Molding time and cycle vary with the size of the part and its shape. The injection-molding process is versatile, and is used to produce a wide variety of quality parts, rapidly and economically.

Low Unit Cost. Another positive value of injection-molded parts is the low cost of fabrication per part. While the initial cost of the mold itself is high, a mass-production operation makes the cost per piece low. Loss of molding material is generally low, too.

No Finishing Operations. With good molding techniques, pieces can be injection-molded to close tolerances. In many cases, molded pieces require no finishing operations. Thus, large savings in time and expense can often be realized.

Simplified Designs. The versatility of injection molding often permits design simplification. Du Pont "Zytel" nylon, for example, can be injection-molded into intricate shapes, as well as around metal inserts. Du Pont "Alathon" polyethylene resin and "Lucite" acrylic resin can also be successfully injection-molded into a variety of useful forms.

E. I. DU PONT DE NEMOURS & CO. (Inc.) POLYCHEMICALS DEPARTMENT
Room 106, Du Pont Building, Wilmington 98, Delaware.

Please send me more information on the Du Pont engineering materials checked: ☐ *"Zytel" nylon;* ☐ *"Alathon";* ☐ *"Teflon";* ☐ *"Lucite." I am interested in evaluating these materials for*_____

NAME_____ POSITION_____

COMPANY_____

STREET_____

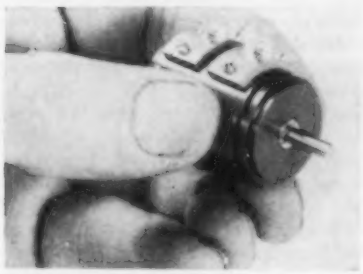
CITY_____ STATE_____

TYPE OF BUSINESS_____

*"Zytel," "Alathon," "Lucite," "Teflon" are trade-marks of E. I. du Pont de Nemours & Co. (Inc.)

the type TR500 transducer is interchangeable functionally with a number of transmitters approved by the Bureau of Aeronautics.

Servomechanisms, Inc., El Segundo Div., 346 Washington St., El Segundo, Calif.



Linear Function Potentiometers

The third in a series of linear function potentiometers with internal clamp ring construction for ganging cups is only $\frac{7}{8}$ in. in diameter. Single cup units are 0.693-in. long from the front of the servo flange to end of case.

Linearity is rated at 0.5 percent standard with 0.25 percent furnished on special order. Wattage rating is 2 w in a single gang unit, 1.5 w in dual ganged units, and 1 w per cup section in multi-gang units. A low torque is provided, 0.25 oz-in. per cup, with lower values available for special applications if required. A resistance range of 400 to 20,000 ohms is standard, higher resistances require special orders.

The potentiometer has a mandrel type winding with all-welded connections. Up to five cups can be ganged on a single shaft, increasing the length by $\frac{1}{2}$ in. per cup section. The internal clamp ring feature permits ganging without increasing the overall diameter.

Fairchild Camera & Instrument Corp., 225 Park Ave., Hicksville, N. Y.

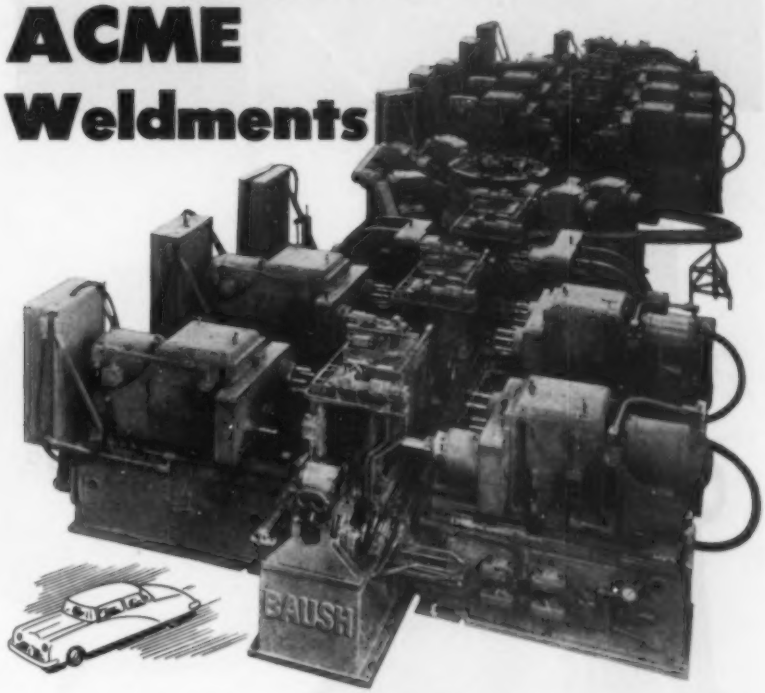
New, Heavy Duty Limit Switch

A new heavy duty limit switch, of M. L. Jeffrey design, is interchangeable with most existing installations and original equipment designs.

It is a single-pole, double-throw, double-break switch which, because of its unique trigger-type mechanism, is said to provide unusually fast and accurate "break". Repetitive accuracy is within 0.03 deg, an accuracy which is reported to eliminate lubrication.

Solid silver contact bars, weighing

AUTOMATION at work ...supported by ACME Weldments



18,240 operations — 80 automobile transmission cases every hour! That adds up to quite a day's work, but it's no problem for this transfer machine built by the Baush Machine Tool Company of Springfield, Massachusetts. Unusual sectional design permits rapid retooling, keeps work handling to a minimum, and speeds production in many of America's largest automotive plants.

To provide the *strength* and *rigidity* required by this complex, automatic machine, Baush engineers specified all-welded steel bases fabricated by *Acme Welding*. Beside being stronger these Acme weldments are lighter and make possible the incorporation of many exclusive design features. Perhaps these advantages of Acme weldments are important to your product . . . whatever your requirements, why not call on Acme *today*.

A.S.M.E. U68-U69 Qualified Welders • A.P.I.-A.S.M.E. Approved
Underwriters Label and Inspection Service • Navy Approved
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Send us your blueprints for a prompt quotation and ask for our informative booklet, "The FACTS about WELDMENTS and CASTINGS."

Acme WELDING
DIVISION of THE UNITED TOOL & DIE CO
1064 New Britain Ave. • West Hartford 10, Conn.
National Representative TRANSMISSION EQUIPMENT CO., Inc.
441 LEXINGTON AVE., NEW YORK 17, N. Y.

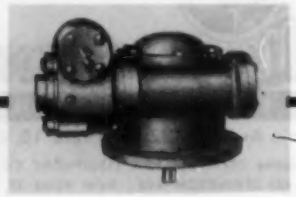
To whip toothpaste into a smooth, lump-free consistency *Abbé Dispersall Mixers use...*

Squeezed with ease from tube to brush, most toothpaste made today owes its smooth, lump-free consistency to Abbé Dispersal Mixers, according to Abbé Engineering Co., New York City.

Within each Abbé unit, two pairs of heavy paddles move through the paste in an intricate pattern with violent turbulence to break up agglomerations of solids and liquid globules. Directly coupled to the motor powering the paddles is a Winsmith Speed Reducer, Worm Gear Model 6 BDV, with an input of 1½ (or 2) hp at 1750 rpm and a reduction ratio of 81¼:1. *Correct stirring speed for thorough mixing is assured!*

Compactness of this Winsmith model, which features a flanged vertical design, proves especially advantageous to Abbé in meeting requirements for cover mounting within low headroom limits.

More than likely, you, too, will find a versatile Winsmith unit to best meet *your* requirements. With fully standardized differential, worm gear, helical gear and worm helical designs available, the Winsmith line is the most complete within its range of 1/100 to 85 hp and 1.1:1 to 50,000:1 reduction ratios. Request catalog 148 for details.

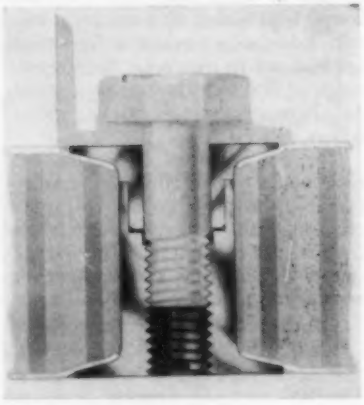


WINSMITH, INC.
111 Eaton St.
SPRINGVILLE (Erie County), N. Y.

only 0.01 oz, are the only "floating" components. They are carried in a balanced rotor, and are locked in each closed position under 10 oz spring pressure. This combination of factors is said to provide a virtually vibration-proof circuit. Even though contact pressure is more than twice that of most limit switches previously manufactured, operating pressure has been reduced, being only 45 in-oz, without return spring and only 185 in-oz with return spring and full overtravel. Without use of overtravel, the new switch has repeatedly passed 25,000,000 actuations. With 20 deg overtravel, operating at 182 times a minute, actuations exceeded 20 million.

Wiring terminals are enclosed in a large compartment completely separated from all moving parts. The sturdy aluminum housing is provided with heavy oil-resistant gaskets meeting ASTM Spec. SC-620-ABEFFZ. The limit switch is normally assembled for lever operation in one direction, with spring return, but may be easily altered at any time for opposite operation or for maintained contact in either direction. Overall dimensions approximate 2¼ x 1¾ x 5¼ inches.

R. B. Denison Mfg. Co., 4220 Hough Ave., Cleveland 3, Ohio



Threaded Spacer Simplifies Fragile Structure Assembly

The new threaded spacer for sandwich type structures announced recently has a tapped sleeve which receives the attaching bolt and eliminates the need for a nut. This is said to result in considerable weight savings per fastener and faster, more convenient installation. The threaded spacer was developed especially for light load applications.

The new spacer provides a means of

Ideas in the making!

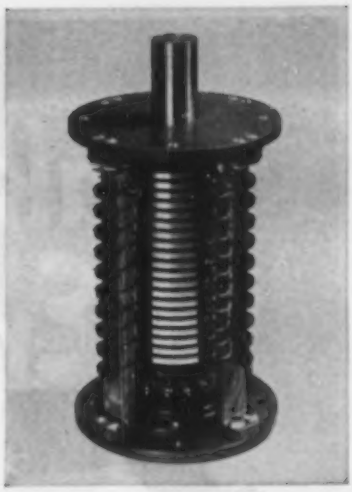
ARALDITE® Epoxy Resins developed by Ciba Research are simplifying manufacturing methods, improving product efficiency and opening new fields of product development. The formulator and the end product producer will want to know more about them. We at Ciba want to help you further your development.

ARALDITE IMPREGNATED MOORING BUOY IS STRONG . . . LIGHT . . . WEATHER-PROOF AND SINK-PROOF

(Courtesy United Pattern Company)

One-seventh the weight of a steel buoy of comparable size including the unicellular filling beneath the surface skin, this newest idea in modern maritime equipment eliminates hull-scuffing damage and is functionally superior in every other way. Since color is "built-in" with salt-water corrosion resistant laminate, it stays bright and new looking, thereby minimizing maintenance. All these advantages suggest a wide range of new and improved product development in which ARALDITE Resins may prove the answer for you.

SEND THIS COUPON . . . or write us on your company letterhead . . . for complete technical data on the physical properties and recommended procedures for the successful use of Araldite Resins for your fabricating needs.



SLIP RING ASSEMBLY

The exceptional casting properties of ARALDITE Resins are demonstrated in this unit designed to operate with strain gauges or radar equipment. ARALDITE Epoxy Resins provide high dielectric strength, arc and humidity resistance which permit a current capacity of 5 amperes per ring.

(Courtesy Airflyte Electronics)

600 VOLT TRANSFORMER TYPE TWM

This example of ARALDITE Resin encapsulating insulation shows how completely it may be applied to encompass coils in housing in an application where rugged use can be expected for the entire life of the unit. *(Courtesy Allis-Chalmers)*

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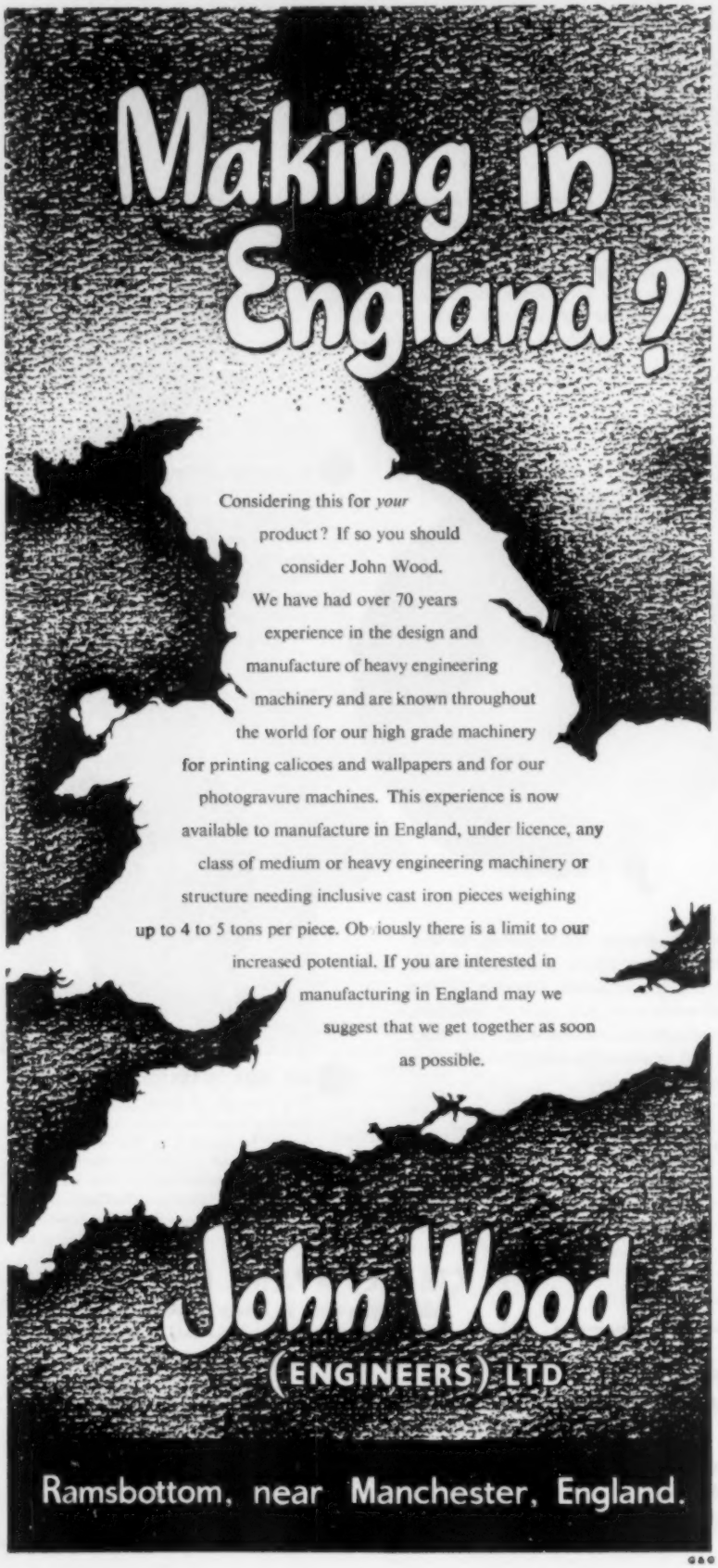
Making in England?
Considering this for your product? If so you should consider John Wood. We have had over 70 years experience in the design and manufacture of heavy engineering machinery and are known throughout the world for our high grade machinery for printing calicoes and wallpapers and for our photogravure machines. This experience is now available to manufacture in England, under licence, any class of medium or heavy engineering machinery or structure needing inclusive cast iron pieces weighing up to 4 to 5 tons per piece. Obviously there is a limit to our increased potential. If you are interested in manufacturing in England may we suggest that we get together as soon as possible.
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Ramsbottom, near Manchester, England.

attaching conduits, cables, instruments and other equipment to sandwich type structures without danger of crushing panels. Other applications include soft woods such as Balsa, and any fragile structure where fastening takeup must be limited to a specified grip length. These spacers are said to assure firm mating of parts and positive, aligned grip. They are available with sleeves tapped 6-32, 8-32, 10-32 and $\frac{1}{4}$-28. Grip lengths are from $\frac{3}{8}$ to $1\frac{1}{4}$ in. Material is 24 ST-3 aluminum alloy, anodized. Installation of all is easily accomplished without special tools.

The Delron Co., Inc., Fasco Div., 5224 Southern Ave., South Gate, Calif.

Sub-Miniaturized Switch

A low-loss twelve-position sub-miniaturized switch is designed for use where space is an important factor and minimum size is required. Only $\frac{3}{4}$ in. square, this new wafer-type selector switch is designed for constant stability in conductivity, and where resistance, inductance and capacitance must be kept to a minimum.

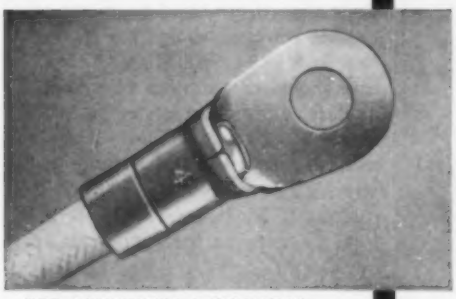
New components have a voltage break-down of 1300 v ac at 115 v, 60 cycles, a current carrying capacity of 3 amp.

The switch has a 30 deg positive detent mechanism with adjustable stops. The rotor blades and stator contacts are solid silver alloy, providing low resistance and high current capacity. A special hole and cutouts are provided in the contact for mechanical attachment of wires.

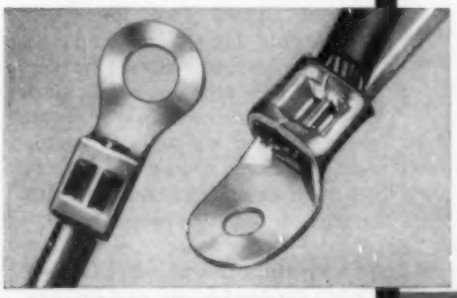
Only high-grade, military specification phenolic is used as the dielectric. (They will soon be available with either L-5 ceramic or "Teflon" insulation). All metal parts, except the silver contacts, are fabricated of quality stainless steel. The rotor shaft may be had in either $\frac{1}{8}$ or $\frac{1}{4}$ in. diameter.

R. F. Electronics, Inc., 291 N.E. 61 St., Miami, Fla.

FOR AMPLI-BOND TERMINALS
A-MP's bonded insulation, Confined "C" Crimp, and insulation support features make precision-engineered AMPLI-BOND terminals the best quality insulated termination for copper wire. Special crimping head applies superior A-MP "C" Crimp for wire sizes 8 through 2.



FOR ALUMINUM CONDUCTOR TERMINATIONS
For applications where weight is the primary consideration, A-MP's novel cartridge type terminals, available in wire sizes 8 through 2, are applied with the same head as that used for AMPLI-BOND. These aluminum wire terminals offer, by way of insulation support, Confined "C" Crimp, and special inhibitor, a completely trouble-free termination.



FOR SOLISTRAND TERMINALS
The AMP W CRIMP for solid wire has two longitudinal indents which compress terminal and wire with a toggle action to produce a voidless, homogeneous mass within the crimp area. There is no finer crimp for solid, irregular shaped or combinations of these wire types.

Find out about the New AMP "CREATIVE APPROACH TO BETTER WIRING"

...An evaluation survey without cost or obligation.

NEW AMP LIGHTWEIGHT HAND HYDRAULIC TOOL

FEATURES:

- 6 TONS FORCE
- SWIVEL ACTION
- SPRING ACTUATED

More than one ton of force per pound of weight makes crimping even No. 2 terminals easier than ever before. Two styles of head are available, one for "W" Crimp, the other for "C" Crimp. The "W" Crimp is for solid and stranded wire and for uninsulated terminations. The "C" Crimp is for insulated terminations on stranded, copper wire and for uninsulated terminations of aluminum wire. Rotating nests or removable inserts give wide wire size range for each head.

It's light! Weighs only 5 lbs. Double lever action of new tool reduces pumping time effort—takes 50% less strokes than conventional hand hydraulic tools. Sudden decrease in pressure indicates to the operator that the crimp is completed.

Literature on tool and terminals available upon request.

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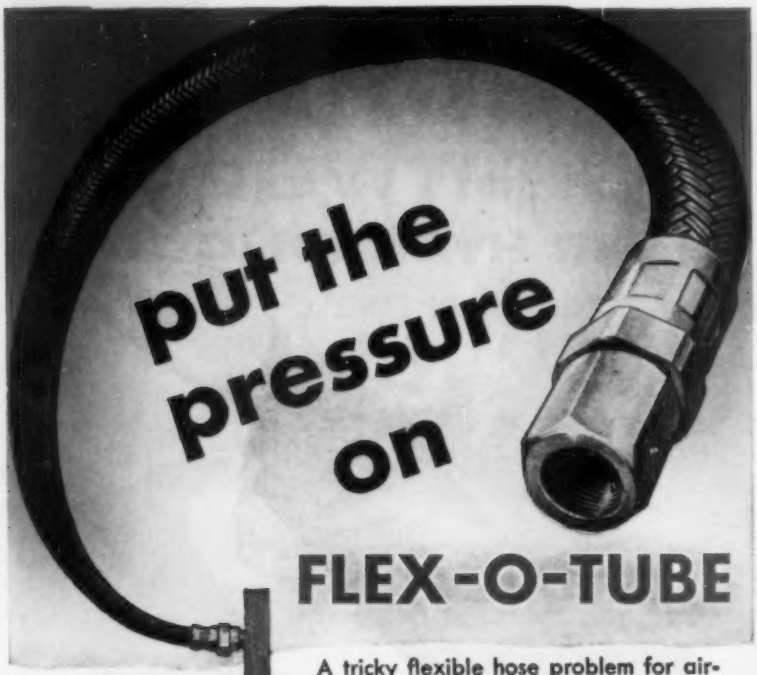

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Catalogs and Bulletins

Request additional information using postcards following page 224

(1) RESISTORS, RHEOSTATS—P. R. Mallory & Co., Inc., Resistor Div., Frankfort, Ind. Catalog, 28 pp, devoted to wire-wound fixed and adjustable vitreous-enamel power resistors and power rheostats. Contains data about characteristics of available military and commercial designs in the forms of descriptions, line drawings with dimensions, charts, curves and large, clear photographs. Also included are hardware, accessories and formulas required for various resistor calculations.

(2) OIL-FILLED CAPACITORS—Industrial Condenser Corp., Dept. PEN, 3243 N. California Ave., Chicago 18, Ill. Brochure, 4 pp. Describes complete line of oil, wax and electrolytic capacitors, including radio interference filters.

(3) PLASTIC RIVETS—Shakeproof, Div. of Illinois Tool Works, St. Charles Road, Elgin, Ill. Brochure, 12 pp. Describes and illustrates types of products and applications in which these plastic self-expanding rivets are used. Included are tables of dimensions of standard rivets and grommets, hole size recommendations and data on strength and other properties.

(4) RUBBER HOSE, BELTING—Carlyle Rubber Co., Inc., 62 Park Pl., New York 7, N. Y. Booklet, 24 pp. Industrial rubber products such as hose belting illustrated and described. Listings give sizes, accessories, prices, working pressures.

(5) SPEED REDUCERS, GEARMOTORS—Eberhardt-Denver Co., 1425 W. Colfax Ave., Denver 4, Colo. Catalog No. 1006, 48 pp. Line of speed reducers, screw conveyor drives

technical bulletin

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a New

TRAILING EDGE ACTUATOR

for Jet Fighters

EEMCO's new rotary actuator, Model D-665, is another example of the complete services rendered by EEMCO. Designed, developed, tested and proven in EEMCO's own plant for a leading air frame manufacturer, this new trailing edge actuator has a normal peak load of 28,000 inch-pounds and a total angular travel of 30°. Other specifications are shown below. Model D-665 can be adapted to other uses and varied specifications with a minimum of time lost in design and production.

SPECIFICATIONS ★ TYPE D-665

Weight: 25¼ pounds
Angular travel: 30° total
Normal peak load: 28,000 inch-pounds
Speed: .675 RPM with average load of 14,000 inch-pounds on 28 volt DC system (18.75 amps.)
Ultimate static load: 77,000 inch-pounds
Auxiliary power take-off
Non-jamming end stops.

Designers and producers of motors, linear and rotary actuators

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and gearmotors are illustrated with photographs and drawings. Their ratings are given in tables. Information on selection of speed reducers, lubricating suggestions and other data included.

(6) THERMISTORS—Carboloy Dept., General Electric Co., Detroit 32, Mich. TH-13, 52 pp, tells what thermistors are, how they are applied, what functions they perform and what benefits derive from them in detecting and compensating temperatures and providing time delay or surge control in electrical equipment. New information on thermistors is included, such as tests by an independent laboratory, characteristic curves for a thermistor carrying current in thermal equilibrium with the ambient and for one where the time delay function is of primary interest, applications, characteristics of thermistor material, explanations of the source and utility of data supplied. Illustrations are keyed so reader can tell which style or type thermistor is best adapted to his application.

(7) BATCH CONTROLLER—The Foxboro Co., Foxboro, Mass. Technical Report TI 29-B-52-A, 4 pp, describes how controller prevents "overshoot" of a variable during startup of batch processes. Diagrams show instrument circuitry and comparative responses of various control actions.

(8) CAM CLUTCHES—Morse Chain Co., 7601 Central Ave., Detroit 10, Mich. Catalog C12-54, 4 pp, describes "Series 200" cam clutches for indexing, over-running and backstop machine drive applications. Application data, typical installation drawings and a complete table of specifications are given for seven models having torque ratings from 10 to 500 ft lb and ground OD dimensions corresponding to standard 200 series ball bearings in nominal sizes from 1½ to 3½-in. outside diameter.

(9) FASTENERS—The Mac-It Parts Co., Lancaster, Pa., Booklet, MC-20M, 32 pp. Shows a complete line of cap screws, set screws, shoulder screws, hollow-pipe plugs, and mining machine screws. Complete data on physical characteristics and American Standards Association dimension standards are included to give accurate specification and engineering. In addition, all

Precision bronze parts . . . *our specialty!* Your blueprints faithfully reproduced in the finest of bearing bronzes. Capacity for production orders available. Free engineering consultation. Address:

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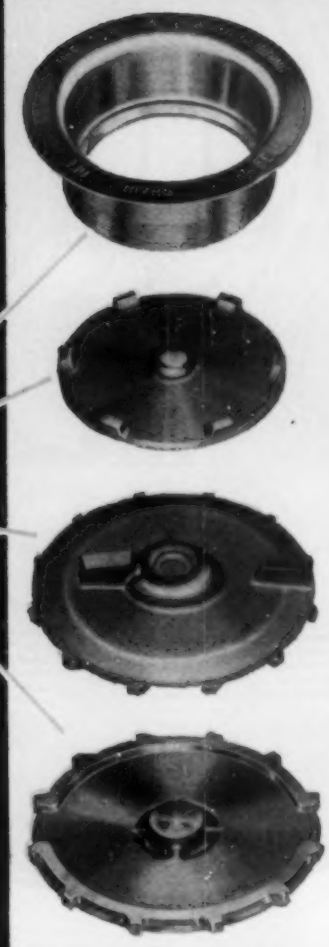
Sleeve bearings in all designs and sizes; cast bronze bushings; bimetal rolled bushings; rolled split bushings; washers, spacer tubes, precision bronze parts and bronze bars.

MUELLER BRASS CO. forgings* contribute to the efficiency of this modern waste disposal unit

***MUELLER BRASS CO. facilities include: designing, die-making, forging, tooling, machining, polishing, plating and assembly**



Three Mueller Brass Co. forgings play an important part in the fine operating performance of this modern waste disposal unit made by the Eureka-Williams Co., Division of the Henney Motor Co., Inc. This unit does a speedy and thoroughly effective job of pulverizing garbage and has made life easier for American housewives. The impeller disposer that chops up the waste food in the disposal unit, the disposer cover and the sink mounting flange are all forged by the Mueller Brass Co. This is another outstanding instance where Mueller Brass Co. forgings have improved product performance and cut costs. High quality forgings can be produced from standard and special brass, bronze and aluminum alloys. And in addition, the Mueller Brass Co. offers complete service ranging from product design to finished part . . . Write today for complete information and new 32 page forgings handbook.

1. Sink mounting flange, forged, machined, nickel and chrome plated by Mueller Brass Co.
2. Machined and finished disposer cover forging.
3. Cutting side of impeller disposer forged from 600 series bearing bronze.
4. Reverse side of impeller disposer.

MUELLER BRASS CO.

PORT HURON 17, MICHIGAN

specifications on the various point styles of hollow set screws have been combined into one chart. Has many photographs, cross-sectional diagrams, and charts.

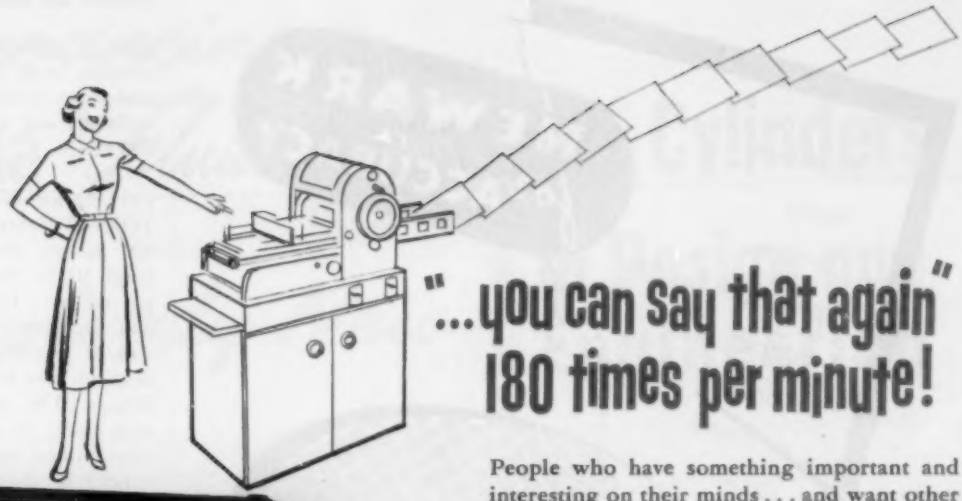
(10) SPRAY LUBRICATING SYSTEM—C. A. Norgren Co., 3428 S. Elati St., Englewood, Colo. Folder, 8 pp. Drawings and photographs explain this spray lubricating system designed for machine tools. Typical applications illustrated and described.

(11) GRINDING, CUT-OFF WHEELS—Sandusky Abrasive Wheel Co., Inc., 623 Ransom St., Kalamazoo, Mich. Catalog, 12 pp. Complete line of rubber and resin-rubber bonded grinding and cut-off wheels, mounted points and abrasive sticks and blocks is included. Specialized facilities for manufacturing special wheels is described. A pricing system claimed to be far simpler and easier to use than any previously found in the grinding industry has also been compiled and is available with the catalog.

(12) GLASS LAMINATES FOR SHELL STRUCTURES—Lunn Laminates, Inc., Oakwood Rd. and W 11 St., Huntington Station, Long Island, N. Y. Brochure, 24 pp, is first comprehensive study of glass fiber laminates for shell structures. Equations, diagrams and charts show advantages of these laminates.

(13) IMPACT EXTRUSIONS—Aluminum Co. of America, 1501 Alcoa Building, Pittsburgh 19, Pa. Booklet, 16 pp, covers significant facts necessary to design products as impact extrusions. Along with illustrated recommendations for various types and shapes of extrusions, tables give suggested wall thicknesses and typical properties and tolerances.

(14) INSULATING VARNISHES—Irvington Varnish & Insulator Div., Minnesota Mining & Mfg. Co., 6 Argyl Terr., Irvington 11, N. J. Catalog contains complete data on all the long established as well as newer types of varnishes available. A special feature is the section entitled, "How to Use Insulating Varnishes". Included in this section is not only valuable general use information, but special instructions on the dipping, vacuum, pressure, brush, spray and baking



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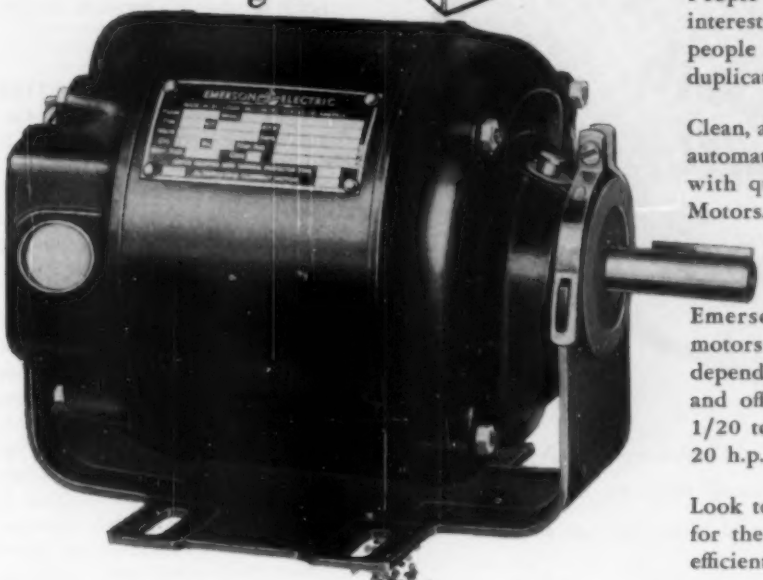
Clean, accurate copies—180 per minute—flow automatically from these machines, powered with quiet, dependable Emerson-Electric Motors.



Emerson-Electric specializes in building motors for equipment with a reputation for dependability. It has done so for 64 years, and offers standard motors in ratings from 1/20 to 5 h.p., and hermetic motors 1/8 to 20 h.p.

Look to Emerson-Electric if you are looking for the right motor to power your product efficiently, dependably. Your inquiry is invited.

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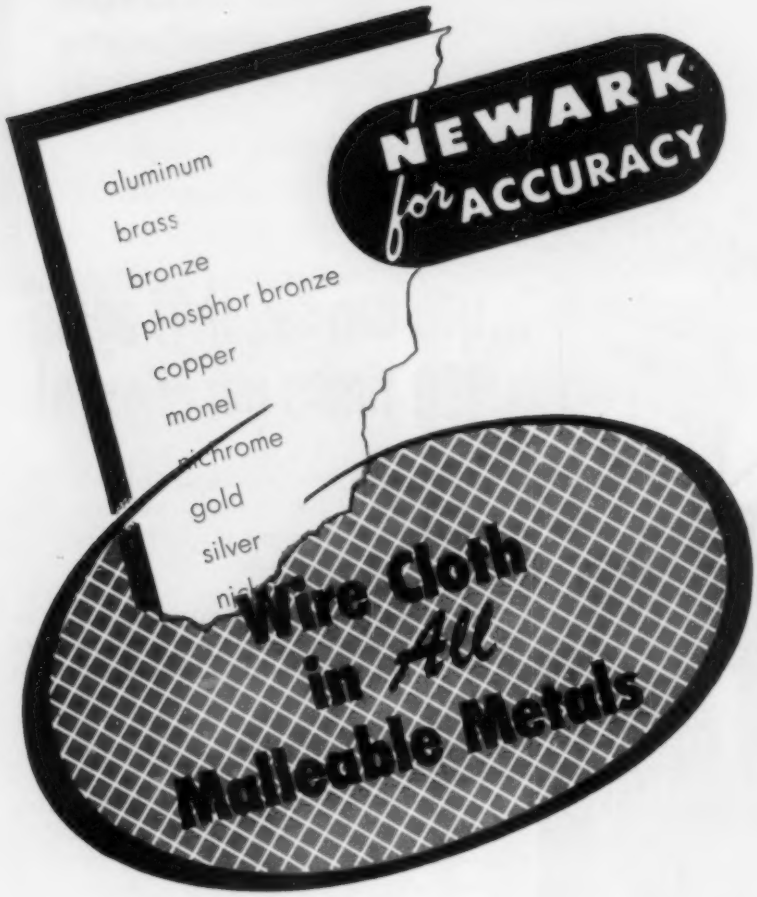
- ☐ M421-A Capacitor-Start
- ☐ M421-B Split-Phase
- ☐ M421-C Integral
- ☐ M421-D Fan-Duty
- ☐ M421-E Oil-Burner
- ☐ M421-F Jet Pump
- ☐ M421-G Blower

EMERSON ELECTRIC

MOTORS • FANS APPLIANCES



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This wide range of metals enables you to select the one wire cloth to meet your conditions of corrosion and/or contamination.

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types of application. Another section contains many useful charts such as conversion tables, solvent charts, tank capacities and specific gravity correction tables.

(15) CURRENT-LIFTING REACTORS—Westinghouse Electric Corp., 401 Liberty Ave., Box 2278, Pittsburgh 30, Pa. Booklet B-5918. Pointing out that "Type MSP" reactors are now available for installation on industrial branch circuits, this booklet describes two ways they provide cost savings. Use of shields to confine stray flux is discussed as well as other constructional and operational characteristics of the 12 standard designs available.

(16) FLEXIBLE STAINLESS STEEL TUBING—The American Brass Co., American Metal Hose Branch, 698 S. Main St., Waterbury 20, Conn. Bulletin STC-1, 4 pp, has data on various types of construction, size and weight ranges, burst pressures, bending diameters and fittings available for assemblies.

(17) COATING, LINING, SURFACING MATERALS — Carboline Co., Div. of Mullins Non-Ferrous Castings Corp., 331 Thornton Ave., St. Louis 19, Mo. Bulletin 100, 4 pp, is an attempt to define the serviceability, cost and life of each material in a line of corrosion resistant coatings. Corrosive service conditions are placed in broad classifications, and coating life is estimated. The practical limitations of each material are made clear by tabulated data. Included are phenolics, furans, neoprenes, vinyls, rubber base resins and epoxies. Primer recommendations are also given.

(18) SERVO MOTORS—G-M Laboratories, Inc., 4300 N. Knox Ave., Chicago 41, Ill. Catalog 4, 4 pp. Sizes of a-c servo motors listed range from 0.980 to 1.70-in. dia and are for use on 60 and 400 cycles at 26 to 115v. Applications range from gun sights and guided missiles through altimeters, direction finders and servo circuits in general.

(19) WIRE-WOUND RESISTORS —Daven Co., 191 Central Ave., Newark, N. J. Catalog, 32 pp. Divided into sections starting with broad general data and continuing into detailed

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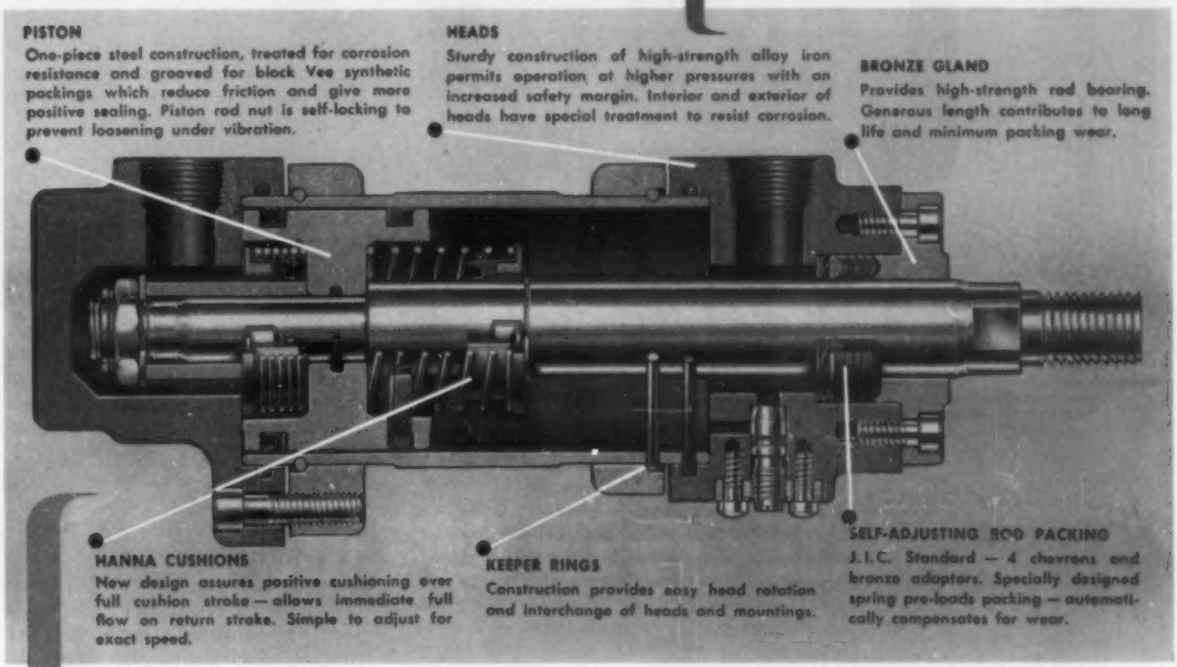
Hanna *Fluid* 750 SERIES *Power* Cylinders

Completely New { in Design and Engineering


PISTON
One-piece steel construction, treated for corrosion resistance and grooved for block Vee synthetic packings which reduce friction and give more positive sealing. Piston rod nut is self-locking to prevent loosening under vibration.
HEADS
Sturdy construction of high-strength alloy iron permits operation at higher pressures with an increased safety margin. Interior and exterior of heads have special treatment to resist corrosion.
BRONZE GLAND
Provides high-strength rod bearing. Generous length contributes to long life and minimum packing wear.
HANNA CUSHIONS
New design assures positive cushioning over full cushion stroke — allows immediate full flow on return stroke. Simple to adjust for exact speed.
KEEPER RINGS
Construction provides easy head rotation and interchange of heads and mountings.
SELF-ADJUSTING ROD PACKING
J.I.C. Standard — 4 chevrons and bronze adapters. Specially designed spring pre-loads packing — automatically compensates for wear.

We didn't design these cylinders with a "new look" in mind — although they have it. What's most important to you is their new performance . . . new operating features . . . and new versatility. The above cross-section illustrates some of the new features . . . study it. And there are other important features too: such as ground, polished, chrome-plated rods of alloy steel; cold drawn brass cylinder tubes; cushion adjustment dials; large fluid passages; and J.I.C. Standard leak-proof "O" ring gaskets.

In performance you will like the greater power developed from dimensionally smaller units in the Hanna "750" Fluid Power line. Because of their broad capacity range, air or hydraulic up to 750 p.s.i., you'll be sure of unusually smooth, dependable and lasting operation in the medium pressure ranges.

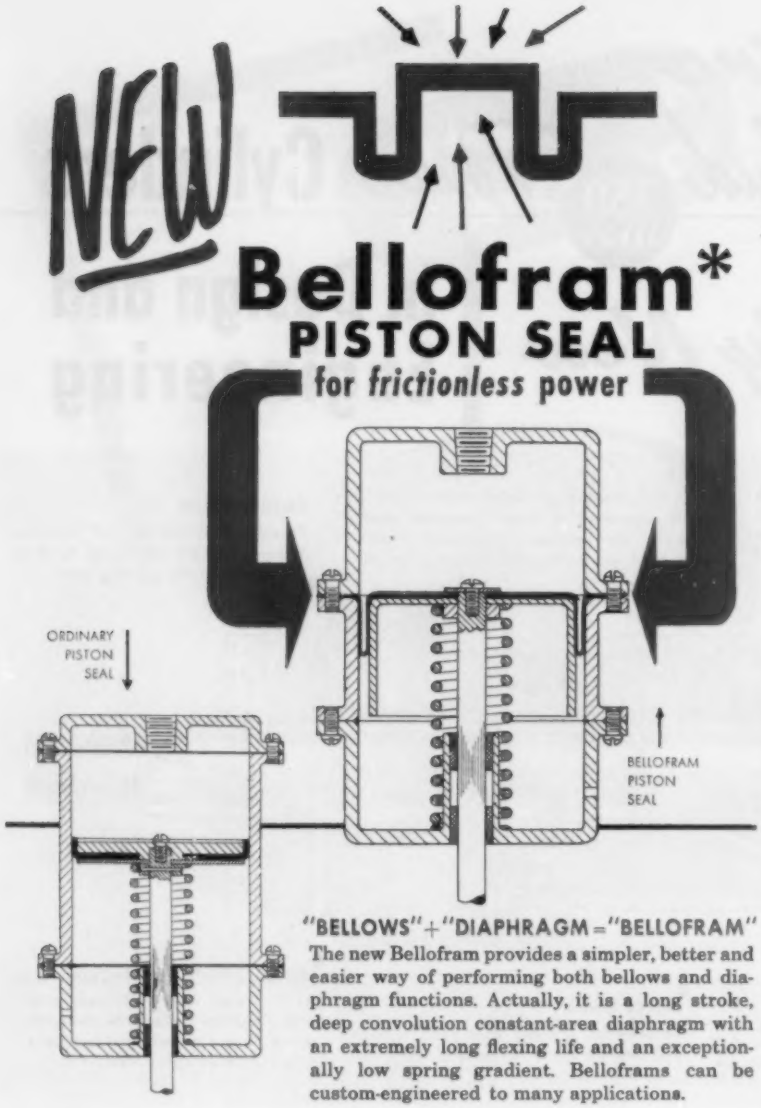
Yes, any way you look at them, inside or outside, Hanna "750" Fluid Power Cylinders are truly new. Together with their proved companions, Hanna LP and Hanna HP Cylinders, they offer a most complete range of capacities, sizes and mounting styles to exactly suit every cylinder application requirement.

Ask your Hanna Representative for details. We will gladly send you a copy of the new "750" Fluid Power Cylinder Catalog. No obligation—WRITE TODAY.

MOUNTING STYLES

Hanna Engineering Works

1763 ELSTON AVENUE • CHICAGO 22, ILLINOIS



"BELLOWS" + "DIAPHRAGM = "BELLOFRAM"

The new Bellofram provides a simpler, better and easier way of performing both bellows and diaphragm functions. Actually, it is a long stroke, deep convolution constant-area diaphragm with an extremely long flexing life and an exceptionally low spring gradient. Belloframs can be custom-engineered to many applications.

BELLOFRAM PISTON SEALS

Belloframs are clean – eliminate gas or fluid leakage and need no lubrication – friction losses low, even under high pressure – relatively unaffected by foreign matter – friction-free rolling action gives exceptional cycle life – have high dielectric strength – remarkably resistant to all chemical action – area accuracies entirely dependent on surrounding rigid parts – adapts itself to chamber or cylinder irregularities. Bellofram Piston Seals do what no other piston seals can do with more accuracy, efficiency and economy.

NEW FREEDOM FOR DESIGNERS

Belloframs give exceptional cycle life. Infrequent and simple replacement is the only maintenance. They can be made to operate at pressures ranging from ¼" H_2O min. to 500 PSIG maximum over a wide range of temperatures. Effective area can be controlled to within less than 0.1% over the working stroke. Ask about a Bellofram designed to meet *your* specific needs. Send us a sketch of your device and we will show you how simply Bellofram may be applied. Strictest confidence observed. Write today.

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* Trade Mark

Bellofram
CORPORATION
144 MOODY ST., WALTHAM, MASS.

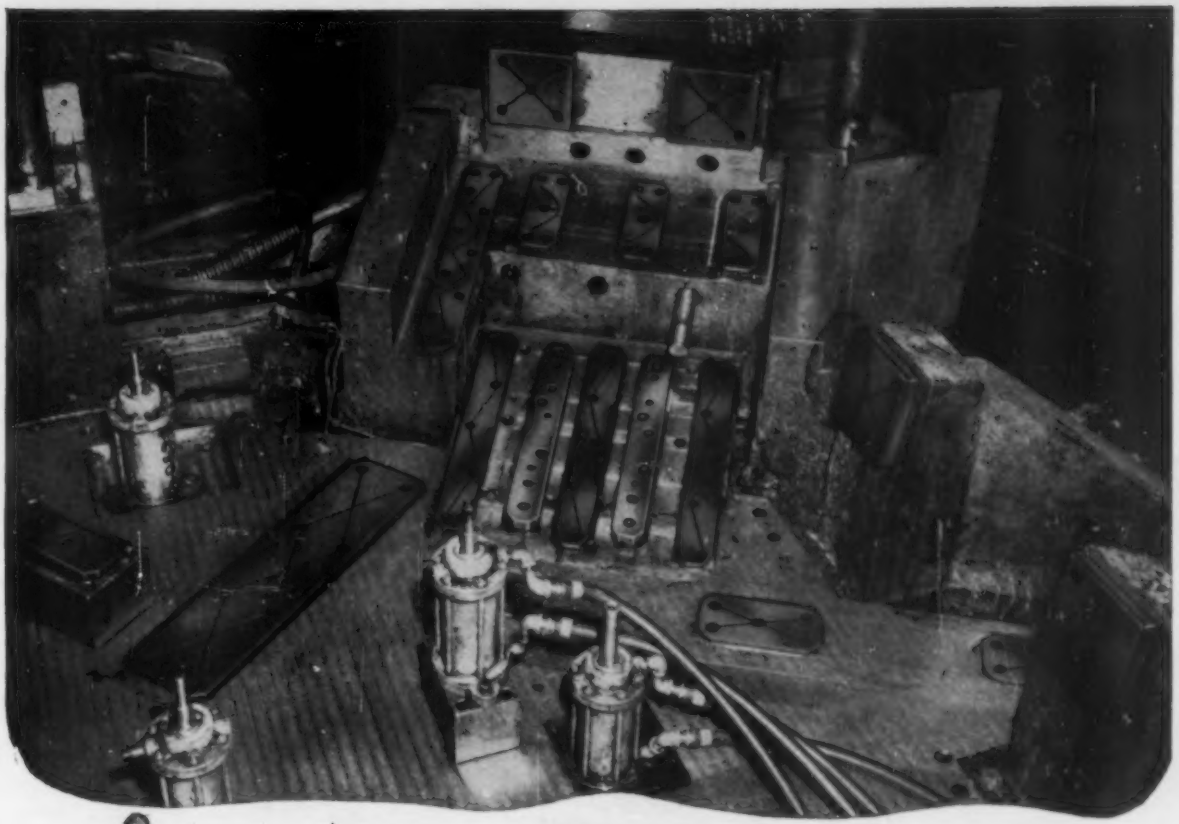
specifications of each type of resistor. Has engineering drawings and photographic illustrations, covering miniature through encapsulated types. MIL and other government ratings are listed. Where applicable, government specifications are cross referenced.

(20) ELECTRICAL WINDINGS, MAGNET COILS—Jeffries Transformer Co., subsidiary of Leach Corp., 1710 E. 57 St., Los Angeles 58, Cal. Bulletin. Illustrates typical coils and windings. Covers applications, manufacture, conductivity and resistivity. Has complete magnet wire characteristics table and tables on temperature coefficient of resistance. Order information and company history.

(21) VOLTAGE REGULATORS—Westinghouse Electric Corp., 401 Liberty Ave., Box 2278, Pittsburgh 30, Pa. Booklet, 20 pp. Fundamental application factors of step and induction voltage regulators are discussed, and charts are used to show graphically what popular practice is today. Both types of regulators are compared from the standpoints of maintenance characteristics and the speed of response factor. Station and pole-type regulators—both step and induction design—are described.

(22) MINIATURE CLUTCHES—Miniclutch Co., 379 Morse St., Hamden, Conn. Bulletin, 4 pp, depicts a line of miniature, one-way roller clutches, which permit drive in one direction with free-wheeling action in the opposite direction. Design and installation data and dimensions are given for roller assembles as well as complete clutches. Information on the essential details of mating parts is also indicated. Typical applications of one-, two- and three-clutch assemblies, with photographs and drawings, are included.

(23) SOLENOID VALVES—Pantex Mfg. Corp., Pawtucket, R. I., Bulletin 55, 6 pp, covers a line of ¾ in. solenoid-controlled, pilot-operated, four-way valves. Models described include true open-center valves of hollow spool construction and have an operating range from 100 to 5000 psi and are interchangeable, mounting and port wise, with many 2000 and 3000 psi-valves. Three basic types of these solenoid valves are available



. . . long wearing, economical OK aluminum bronze wear plates

Practically every important automobile manufacturer now uses OK aluminum bronze wear plates on body dies.

By a unique cladding process, long-wearing aluminum bronze is bonded to a machinable steel base. Cost is drastically lower when compared to solid cast bronze plates. A finer quality bearing surface is obtained, resulting in longer life. When fitting is required to suit die, steel backing of plate is easily machinable, and no difficulty is encountered drilling or counter boring through bronze surface. OK aluminum bronze plates are applicable wherever a die has a sliding or cam action. A large selection of sizes of OK aluminum bronze plates is carried *in stock* . . . finished ground, flat and parallel . . . ready to ship. Simply send your drawings or sketches to our engineering department.

Manufacturers for the metalworking industry of:
SLITTER KNIVES • SHEAR BLADES • BRONZE WAYS ROTARY SHEAR KNIVES • HARDENED SPACERS • BALL RACES • HARDENED WAYS • WEAR STRIPS • GIBS

THE OHIO KNIFE CO.
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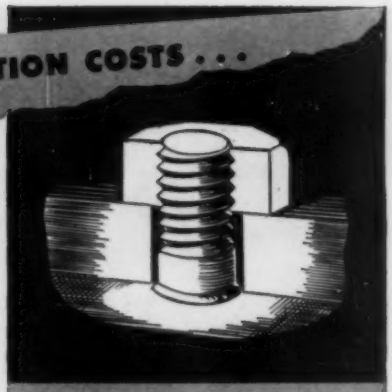
TO REDUCE PRODUCTION COSTS . . .

SIMPLIFY AND ELIMINATE WITH KSM STUD WELDING

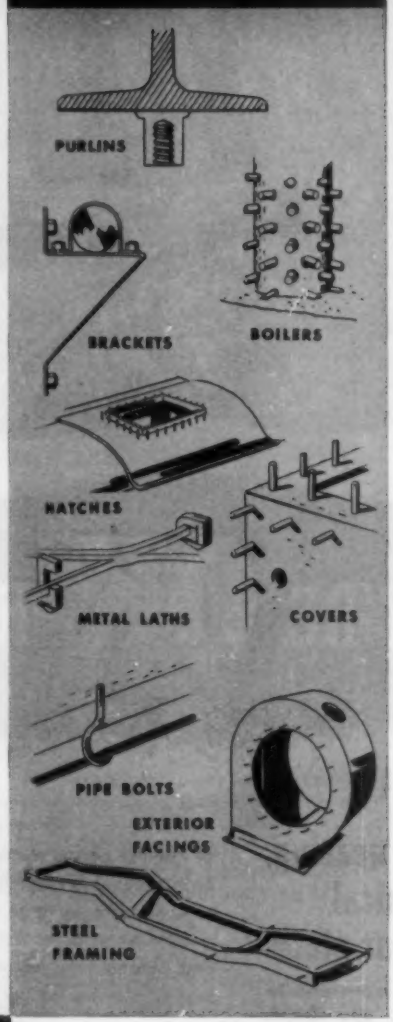


Time-consuming drilling, tapping, grinding and the need for elaborate jigs and fixtures can be eliminated when stud welding is specified for fastening applications. Both design and assembly are simplified, production is boosted while substantial savings in labor and material costs are realized.

Stud welding is the efficient, fast application for plain studs, male or female threaded studs, with or without shoulders, eye-bolts, J-bolts, pins and a wide variety of square, rectangular, straight or bent shapes. Its applications are unlimited and have been thoroughly proved on countless applications.

Studs can be applied at the rate of six per minute and located within tolerances as close as .005 inches. True 90 degree positioning is assured. Weld strength exceeds that of the stud and the parent metal.

Some typical uses of stud welding are suggested and types of studs available are shown here. Whether or not your needs are illustrated, think in terms of stud welding. Investigate what it can do for you. Get the complete story of KSM engineered benefits. Write KSM Products, Inc., Merchantville 8, N.J.



KSM
STUD WELDING

solenoid valves are available with a total of 24 variations made possible through the use of two different subplates and six spool types.

(24) SPROCKETS, FLEXIBLE COUPLINGS, HUBS—Cullman Wheel Co., 1344 W. Altgeld St., Chicago 14, Ill. Catalog, 16 pp, illustrated with photos and listings, sizes, prices and instruction data are given. There are also sections on uses, advantages, adaptability and flexibility of their interchangeable bushing system.

(25) CHAIN DRIVES—Ramsey Chain Co., Inc., Albany, N. Y. Catalogue 154, 19 pp, provides data on operating characteristics and service factors of chain drives. Information is included on how to select and order the proper drive. Heavy duty drives are described and details on lubrication, installation and maintenance are included. Complete list of district sales and engineering offices and authorized distributors and representatives.

(26) SHOCK AND VIBRATION ISOLATORS—Barry Corp., Watertown, Mass. Bulletin 538, 4 pp, presents detailed technical and application information on the "Series 670" and "Series 297" shock and vibration isolators. These units are designed to reduce shock and noise caused by impact-type machines, and vibration and noise caused by heavy rotating and reciprocating machines. Isolators in seven load ratings, covering the range from 500 to 4400 lb per unit isolator, and with their isolation efficiency for vibration at about 70 percent at 20 cps (1200 rpm) and 90 percent at 1800 rpm, are described. Included are data on dimensions and loads, installation procedures, variation of natural frequency with load, percent isolation of vibration for various frequencies and applied loads and performance under shock.

(27) CAM FOLLOWER ROLLERS —Smith Bearing Co., Trenton, N. J. Folder, 6 pp. Gives a detailed description of a new high capacity stud cam follower as well as the maker's regular type of follower. Load and life ratings are given and specifications for both models are included.

(28) ELECTRIC BRAKES, CLUTCHES—Warner Electric Brake & Clutch Co., Beloit, Wis., Bulletin

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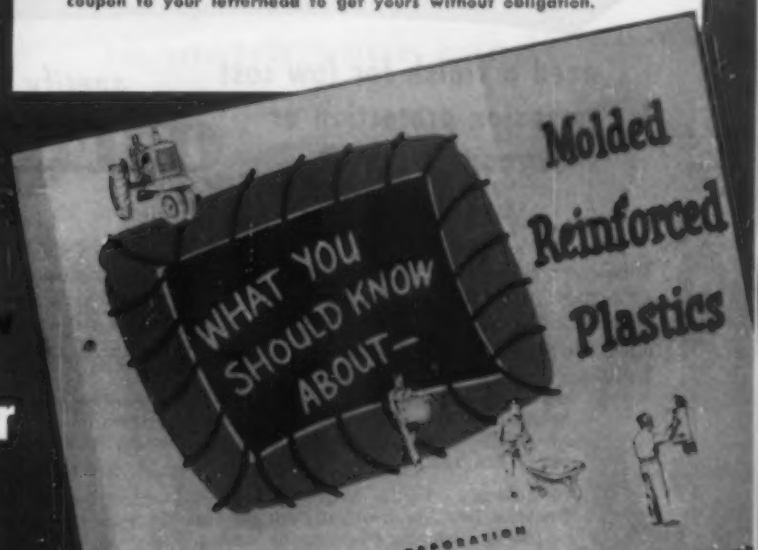

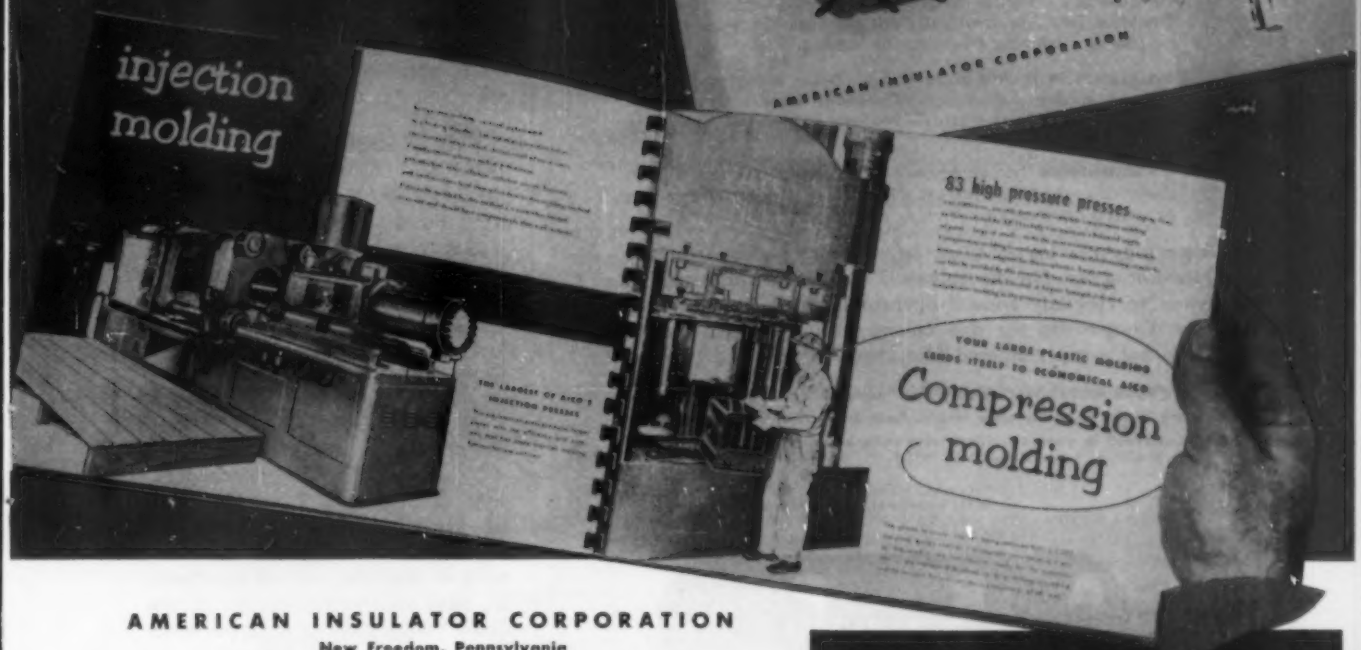

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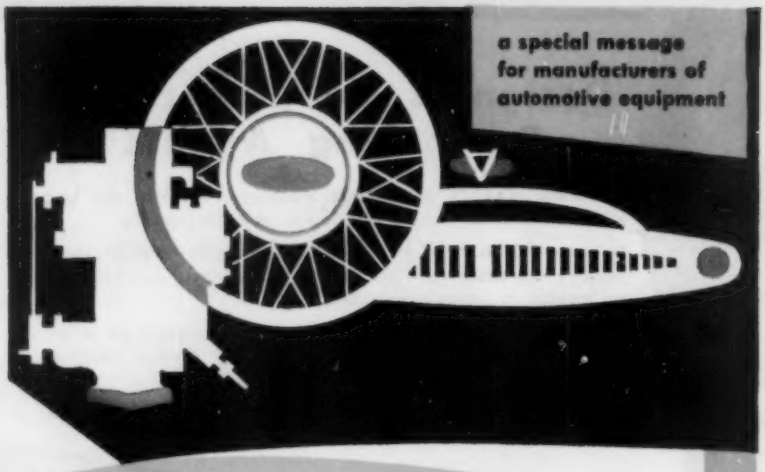

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Whether you're finishing non-ferrous parts for high corrosion protection, paint base, or for showroom sales appeal, you can be sure of low material and production costs and peak performance when you specify Iridite. Here's what you can do with Iridite:

- **ON ZINC AND CADMIUM** you can get highly corrosion resistant finishes to meet any military or civilian specifications and ranging in appearance from olive drab through sparkling bright and dyed colors.
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AND IRIDITE IS EASY TO APPLY. Goes on at room temperature by dip, brush or spray. No electrolysis. No special equipment. No exhausts. No specially trained operators. Single dip for basic coatings. Double dip for dye colors. The protective Iridite coating is not a superimposed film, cannot flake, chip or peel.

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Catalogs and Bulletins.....continued

No. 6158, 6 pp, describes and illustrates with photographs and engineering drawings the replaceable face electric brakes and the bearing-mounted and flange-mounted electric clutch couplings made in a range of armature hub and rotor hub bore diameters. Wattage ratings available are 10 and 15w, max. Table of specifications is included.

(29) POWER CONTROLS FOR ELECTRONIC SYSTEMS—Automatic Switch Co., Orange, N. J. Publication 528, 44 pp, describes services and products for use on the power side of electronics systems. Discusses items designed and constructed to RETNA standards and covers such controls as automatic transfer switches, engine-generator starting units, differential relays, time delay relays and complete control panels. Information is given on such related subjects as: current surge tests, adequate lighting, relay protection; auxiliary equipment for engine generator controls.

(30) METAL "O"-RINGS—United Aircraft Products, Inc., Ring Div., Box 1035, Dayton 1, Ohio. Bulletin 54391, 20 pp, deals with vented and standard "O" sealing rings and their various industrial applications where they are used for static sealing of high and low pressures and temperatures. Illustrates typical points of installation of these rings in several products.

(31) FLEXIBLE SHAFT ACCESSORIES—S. S. White Industrial Div., 10 E. 40 St., New York 16, N. Y., 4 pp, Bulletin 5403 describes a line of aircraft accessories for use with flexible shafts. Included are engineering drawings, dimensions and operating characteristics of mechanical screw jacks, pressure bulkhead fittings and flexible adapters.

(32) SELENIUM RECTIFIERS—Sarkes Tarzian, Inc., Rectifier Div., 415 N College Ave., Bloomington, Ind. Catalog 666, 72 pp. This new handbook includes an up-to-date rectifier replacement guide. Different types of selenium rectifiers are treated in detail in separate sections of the book. Suggestions for applications and engineering data provided.

(33) SLIDE RULE FOR THERMOSTATIC CALCULATIONS—Mechanical Industries Production Co., 217

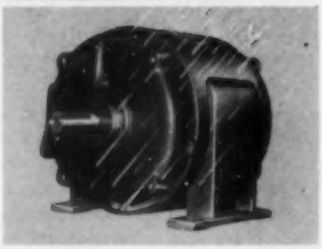
NEW Century Performance-Rated® INTEGRAL H.P. MOTORS

Now available in
1 . . . 1½ . . . 2 H.P. sizes—
NEMA frames 182 and 184.

Improved Motors to match your needs

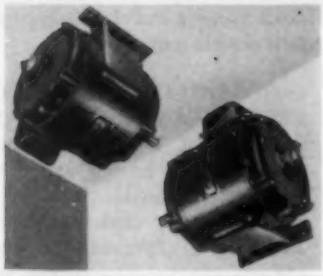
SMALLER — LIGHTER

More uniform silicon-laminated steel; thinner, *tougher* "Mylar" slot insulation — just two of the many technical developments that help make these new Century Performance Rated Motors so much *smaller* and *lighter*.



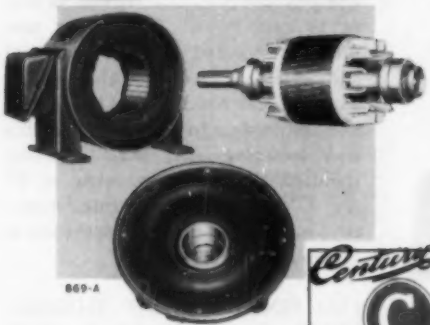
BETTER PROTECTION

New concepts of internal motor ventilation permit end bracket and frame design that gives far better protection from falling liquids and solids . . . still maintain 40°C. temperature rise.



MORE FLEXIBLE MOUNTING

You can even have cushion mounting with these new Century Integral H.P. Motors — your choice of sleeve or ball bearings. Ball bearing motors mount vertically, upside down, in any position. End brackets can be rotated for top protection in any position.



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EVEN MORE DEPENDABILITY

Improved plastic impregnating varnish and plastic insulated magnet wire provide unusual resistance to abrasion, moisture and heat. These new materials possess far better dielectric qualities. Die cast aluminum rotors are individually, dynamically balanced to assure freedom from vibration.

Call Your Century Application Engineer...

Ask him about the new Century Performance Rated Integral and Fractional H.P. Motors.

Offices and Stock Points in Principal Cities

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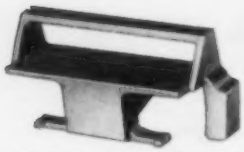
FACTS ABOUT ATLANTALLOY PRECISION PLASTER MOLD CASTINGS

One-piece cast ice cutter for York Corporation's Automatic Ice Maker replaced fabrication of several stainless steel parts.



Cast brush holder for General Electric aircraft generators lowered costs, provided closer tolerances and increased strength.

Lever casting of *Atlantalloy* #31 manganese bronze with tensile strength of 100,000 psi for Sargent & Greenleaf's manipulation-proof lock.

Rugged skirt door operating mechanism cast for Pennsylvania Railroad cars manufactured by the Budd Company.

• ATLANTALLOY PRECISION PLASTER MOLD CASTINGS • ATLANTALLOY PRECISION PLASTER MOLD CASTINGS • ATLANTALLOY PRECISION PLASTER MOLD CASTINGS •

Today, **ATLANTALLOY CASTINGS** are used where precise dimensions and high physical values *plus* economy are essential. These unique precision plaster mold castings can improve *your* product design and reduce *your* costs:

PRECISION — Meet precision machining tolerances. Average limits, ± .005 on one side of parting line. Minimal or no machining or finishing.

DESIGN — Compared with other techniques, this casting process makes possible the production of parts which, because of high physical properties, could not economically be produced by other means. Complicated assemblies requiring several machined parts can be cast accurately as one piece, including designs having internal teeth, stops and blind gear teeth. A wide range of *Atlantalloys* are available for your design needs. Chemical certification on request.

EXCLUSIVE CASTING FEATURES — No gas formation when metal enters mold, and no ebullition of liquid metal. Self-venting molds yield to metal, cool slowly. Castings are practically stress-free with superior grain structure. Loose cores permit "impossible" designs. Finishes are exceptionally smooth and clean.

ECONOMY — Major savings in machine work because of high finish, uniformity and accuracy. End costs below machined parts from rougher-type castings, *even for limited volume runs.* Greater savings for large runs. Time and material savings since uniform castings always fit your jigs and fixtures without rejects. Tool life extended because castings have no blow holes, hard spots, or inclusions.

SALES REPRESENTATIVES

Middle Atlantic States — Beemer Engineering Co., 401 North Broad St., Philadelphia 8, Pa.

New England — J. C. Tarbel Associates, Inc., 64 Park St., Springfield 2, Mass.

More facts on "High Quality Precision Castings for Industry". Write for your free copy!

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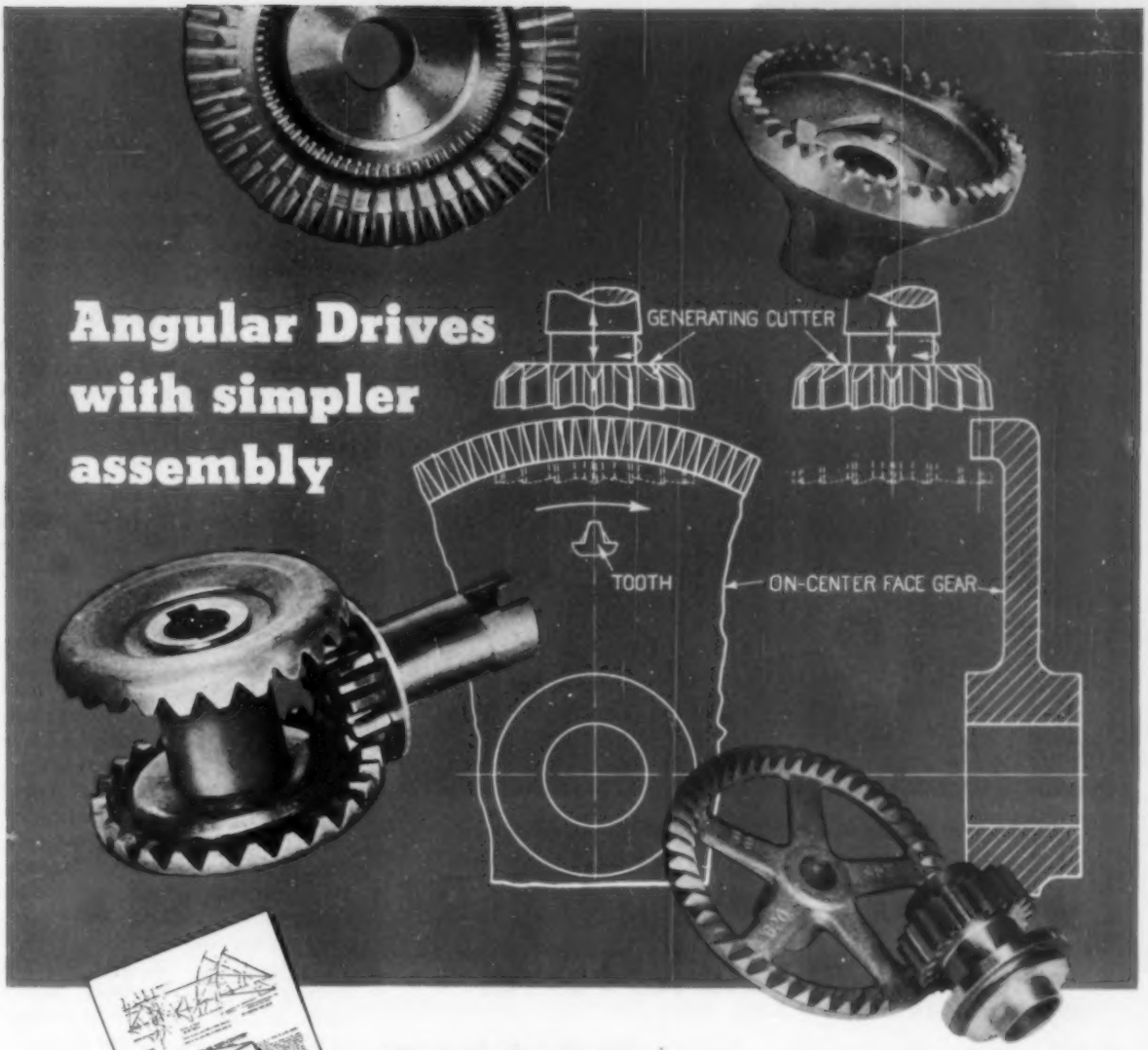
Ash St., Akron 2, Ohio. Slide rule computer designed to fit into project work books is being distributed to engineers engaged in thermostatic work. It incorporates all nine standard scales including Cl reciprocals. It is 10 in. long, 4 in. wide. This new slide rule contains suitable formula for calculating applications for thermostats, used to protect sub-fractional horsepower motors, air conditioners, window and exhaust fans, lighting transformers, signal equipment. In addition to standard scales, the slide rule contains trigonometric formula for right triangles, sines and limits of value by quadrant as well as natural functions. Also included are slide rule settings for general equivalents, a 4-place logarithmic table, decimal equivalents to thirty-seconds and a long list of commonly used arithmetic, algebraic and geometric formuli. A complete set of standard slide rule directions is included.

(34) UNIONS, CHECK VALVES—Catawissa Valve & Fittings Co., Catawissa, Pa. Catalog 11, 24 pp, contains engineering data and specifications on hot forged steel pipe unions and swing check valves. In addition, full alloy and full stainless steel unions are also described. A special section is devoted to double-start unions, which are said to provide 280 percent faster opening and closing by virtue of their double-start threads.

(35) CAPACITORS—Astron Corp., 255 Grant Ave. E, Newark, N. J. Catalog AC-4, 48 pp. Latest available types, complete listings, and technical data on electrolytic, paper-foil, and metallized-paper capacitors, arranged according to operating temperature and performance characteristics as well as by case types. Among the new products included are plastic encased and sealed paper units with a special patented seal which makes the capacitors impervious to moisture, humidity and soldering iron heat. Familiar standard types for operation at 85 deg C and high-temperature, miniature, metal-cased units for operation at 125 deg C are also shown.

(36) BIMETAL STRIP THERMOSTATS—Stevens Mfg. Co., Inc., 69 S. Walnut St., Mansfield, Ohio. Bulletin, 2 pp, describes company's line of Type W bimetal strip thermostats for use

Angular Drives with simpler assembly



Special instruction sheets for determining the active face width of both 'on-center' and off-center' face gears will be sent free of charge. Copies may be obtained by writing the nearest Fellows office.

Face Gears...offer an inviting design solution to 90° and other angular drives. Outstanding advantages of face gear applications are: more compact design, easier assembly, and capacity for high speed.

Both face gear and pinion can be produced with great accuracy on the Gear Shaper, and at costs so low that designers prefer face gears for many angular drives. A special bulletin of principles and applications of face gears is yours for the asking.

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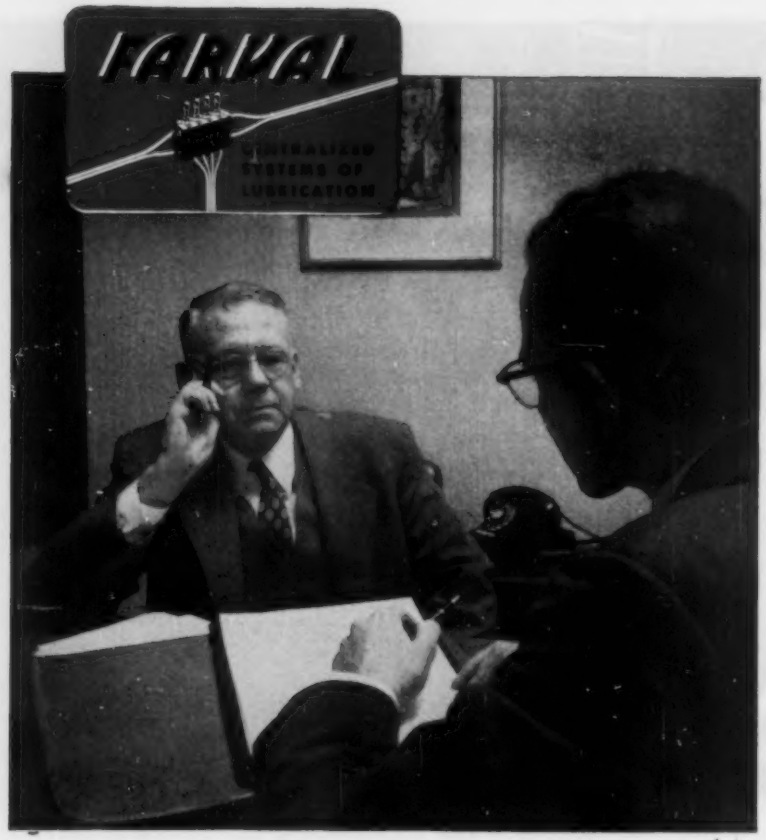

PRESIDENT REPORTS ON CENTRALIZED LUBRICATION

"Our first year's savings of $41,184 more than paid for Farval"

ONCE a day, every day of the week, 133 presses in a midwestern metal-working plant were stopped for oiling. It took all of 11 men's time to do the job. Sometimes certain bearings were missed. So, shutdowns for bearing repairs and parts replacement were frequent and *expensive.*

Then management learned of Farval Centralized Lubrication. They invested in 133 Farval systems for their presses. Results were immediate and startling! Not a single shutdown for oiling! Not a single shutdown for repairs! Not a single shutdown for replacement of parts due to inadequate lubrication. Farval eliminated the "human element" and saved $41,184 the first year in man hours alone. In addition, there was a 75% savings in lubricant and hundreds of production hours have been saved. *All this in just one year!* With comparable savings reported *each year,* no wonder this company is so overwhelmingly in favor of centralized lubrication!

FARVAL is the foolproof Dualine system of centralized lubrication that delivers a measured amount of clean lubricant at regular intervals to every bearing. From a central station, lubricant is pumped under pressure to a measuring valve at each bearing, delivering the exact amount of lubricant required.

FREE LUBRICATION SURVEY—Let us send one of our lubrication engineers to inspect your plant equipment. Without obligation, he will present a written analysis of what Farval can do for you. Write also for Bulletin 26 for the complete Farval story.

The Farval Corporation

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in refrigerators, rectifier fans, electronic and avionic devices and industrial apparatus requiring sensitive, precise control of high-wattage heater loads is described. Operating principles, ratings, construction details, dimensions and various terminal arrangements shown in diagrams, tabular data and photographs.

(37) RUBBER "O" RINGS—Goshen Rubber Co., Goshen, Ind. This 12-pp brochure gives detailed information on compounds, groove dimensions and sizes. Also contains diagrams of typical applications.

(38) FLUSH LATCHES—Hartwell Co., 9035 Venice Blvd., Los Angeles 34, Cal. Catalog, 48 pp, illustrates and describes dimensions, assembly, installation, combinations, parts list.

(39) TOGGLE SWITCHES—Micro, Div. of Minneapolis-Honeywell Regulator Co., Freeport, Ill. Catalog Number 73a, 12 pp, covers 19 precision snap-action toggle assemblies and over ninety AN and JAN approved designs, including assemblies that will control anywhere from 1 to 24 separate electrical circuits. The catalog has complete dimensions, operating characteristics, electrical ratings and contact arrangements on aircraft, mobile, marine, railway and other low voltage d-c applications. All have standard bushing or panel mounting connections. In many cases there is a choice of either solder, lug or screw terminals.

(40) AIRCRAFT FLUID PRESSURE SWITCHES—Aircraft Controls Co., Div. of Gorn Electric Co., Stamford, Conn. Bulletin 101, 4 pp; describes both metallic diaphragm and metallic bellows types of fluid pressure switches, all of which meet basic Army, Navy, and Air Force standards. Pressure, high and low differential pressure, altitude and other special purpose types are included, together with float switches.

(41) METAL BELLOWS—Flexonics Corp., Maywood, Ill. Catalog 140, 16 pp, and design guide covers manufacture, design, applications and specifications for bellows in stainless steel, monel, brass and other metals.

(42) TUBE FITTINGS—Dekoron Products Div., Samuel Moore & Co.,

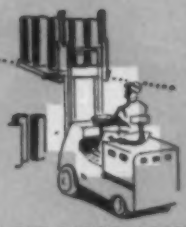
WHERE'S THE LIMIT TO WHAT YOU CAN DO WITH

Hydraulic Power?

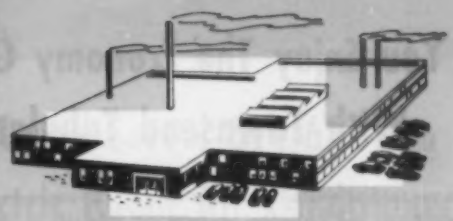
IMPROVE PRODUCT PERFORMANCE

BROADEN PRODUCT USEFULNESS

AID CUSTOMER CONVENIENCE



CUT LABOR COSTS



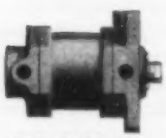
—and boost productivity in your plant!

Hydraulic power has benefited hundreds of products and can help countless more. But NONE so much as the machinery in your own plant! For hydraulics applied to machine set-ups and operations can cut your costs substantially and increase output.

Why pay for labor over and over and over?—when hydraulics can replace manual effort on forming, handling, machining, finishing, and other operations; and do a faster, better job with less chance for error.

Invite your local Rivett Representative to visit your plant—study your processing—and make recommendations. He'll lower your costs and put you in a far better competitive position.

RIVETT FURNISHES A COMPLETE LINE OF AIR AND HYDRAULICS— CAN PROVIDE ANY REQUIRED CIRCUIT FOR ANY TYPE APPLICATION!



Hydraulic Cylinders
108 models

Hydraulic Valves
160 models

Hydraulic Power Units
17 models

Air Cylinders
84 models

Air Valves
34 models

AUTHORITIES—in applying air and hydraulic power

Baltimore, Md.—Colliflower, Inc., Baltimore National Pike, Ellicott City, Md.
Boston, Mass.—L. W. Sheehy, 1104 Park Square Bldg.
Buffalo, N. Y.—Lane Engineering, 1807 Elmwood Ave.
Chicago, Ill.—MacMillin Engineering, 1737 Howard St.
Cincinnati, O.—Seifreat-Elstad Machy., P.O. Box 2508
Cleveland, O.—Garco Machy., 21000 St. Clair Ave.
Columbus, O.—Seifreat-Elstad Machy., P.O. Box 922
Dallas, Tex.—Womack Mach. Supply, 6409 Maple
Dayton, O.—Seifreat-Elstad Machy., P.O. Box 332
Detroit, Mich.—Fors Sales Co., 2832 E. Grand Blvd.
Flint, Mich.—Shively Bros., Inc., 719 E. 2nd Avenue
Los Angeles, Calif.—Paul-Munroe Co., 4865 E. Gage Ave., Bell, Calif.
Milwaukee, Wis.—MacMillin Engineering Corp., 1737 Howard St., Chicago 26, Ill.
Minneapolis & St. Paul, Minn.—Anderson Machine Tool Co., 2641 University Ave., St. Paul.
Newark, N. J.—The Airoyal Company, 1977 Springfield Ave., Maplewood, N. J.
New York City—The Airoyal Company, 6 Church St.
Philadelphia, Pa.—The Battersby Co., 3701 N. Broad St.
Pittsburgh, Pa.—F. R. Magill Co., 44 McKnight St.
Portland, Oregon—Hydraulic Power Equip. Co., 2316 N. W. Savier St.
Richmond, Va.—Industrial Supply, 15th & Franklin
Rochester, N. Y.—Genesee Machine Builders, Inc., 1732 Hudson Ave.
St. Louis, Mo.—William Scheer Co., 6376 Clayton Rd.
Salt Lake City, Utah—J. M. Grisley Mach. Tools, 375 S. W. Temple St.
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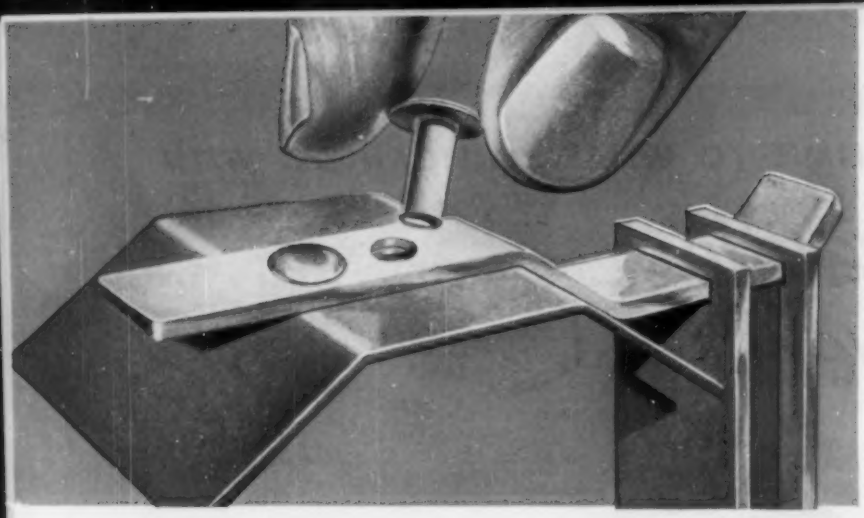
Tulsa, Okla.—John G. Burke & Co., P.C. Box 1652
Wichita, Kan.—Ficke Engr. & Supply, 305 Pattie
Toronto, Ontario—D. M. Duncan Machy. Co., Ltd., 197 College St.
Windsor, Ontario—D. M. Duncan Machy. Co., Ltd., 1958 Wyandotte St.

Dept. PE 6 RIVETT LATHE & GRINDER, INC. • Brighton 35, Boston, Mass.

WHEN YOU APPLY HYDRAULIC OR AIR POWER *Plan with* **RIVETT**

Air and Hydraulic Valves and Cylinders, Hydraulic Power Units.



You Enjoy The Economy Of Quality With Townsend Tubular Rivets

If you use tubular rivets in your assembly operations you know that uniform physical properties and accurate dimensions are essential to efficient operation. We, at Townsend, know it too. That is why wire of the proper grade and analysis is drawn to specifications in our own wire mill to assure positive control of the quality you enjoy when using Townsend tubular rivets.

Since tubular rivets are set with comparatively little pressure, they are often used in materials which cannot stand the impact required to set solid rivets. In these cases the uniform ductility of Townsend tubular rivets is doubly important.

Townsend tubular rivets feed readily into any make of automatic machine—may also be set easily by hand. Their appearance is good—adds to the attractiveness of your product. They weigh less than many other types of fasteners—reduce product weight.

The majority of Townsend semi-tubular rivets are made with an extruded hole which is tapered. When set, there is more material in the clinched end which produces great holding power and develops a shear strength comparable to other fasteners.

Townsend tubular rivets are used extensively in the electrical industry for assembling radio and television sets—in the automotive industry to assure safe, positive fastening of lining to brake shoes—in the furniture industry and many others where quick, secure, economical assembly is desired. These rivets are available in a wide range of sizes in steel, brass, aluminum and copper.

In addition to being the world's largest manufacturer of a complete line of rivets, Townsend has become known as "The Fastening Authority"—has developed special skills and accumulated experience in assembling products of metal, wood, plastics, fabrics and glass. This knowledge enables Townsend engineers to help select or design the fastener best suited to your product and assembly methods. They have over 10,000 special and standard items to draw upon. Also, Townsend's tremendous capacity of 60-million pieces daily is your assurance that delivery will keep pace with your production. You can depend upon Townsend as a reliable source of quality fasteners at a reasonable cost. To enjoy the economy of quality—specify Townsend fasteners.

Townsend

COMPANY • ESTABLISHED 1816

NEW BRIGHTON, PENNSYLVANIA

Sales Offices in Principal Cities

Cherry Rivet Division • Santa Ana, California

THE FASTENING AUTHORITY—Experience: *over 138 years*—**Capacity:** *sixty-million parts daily*—**Products:** *over ten-thousand types of solid rivets–cold-headed parts–Cherry Blind Rivets–Twinfast Screws–self-tapping screws–tubular rivets–locknuts–special nails–formed wire parts.*

Plants: *New Brighton, Pa.—Chicago, Ill.—Plymouth, Mich.—Santa Ana, Calif.*

In Canada: *Parmenter & Bulloch Manufacturing Company, Ltd., Gananoque, Ontario*

Mantua, Ohio, Bulletin, 2 pp, describes fittings designed especially for use with "Dekoron" plastic instrument tubing or "Impervapak Poly-Cor", types of multiple tube instrument line harness . The bulletin is illustrated with exploded and section views, and gives part number and dimensional data for ordering.

(43) GERMANIUM DIODES AND TRANSISTORS—Radio Receptor Co., Inc., 251 W. 19 St., New York 11, N. Y. Bulletin No. G-23 is fully illustrated with charts, voltage curves and diagrams and lists product applications. A total of 32 different germanium diodes are listed, including four JAN types and nine hermetically sealed diffused PNP junction transistors.

(44) ELECTRIC INSTRUMENTS, ACCESSORIES—Burlington Instrument Co., 153 N. 3 St., Burlington, Iowa. Catalog N-1 presents characteristics of instrument design in respect to size, type of material of the case and style of mounting in a series of column headings, under which the consecutive sections are listed with prices for the different types of instruments such as microammeters, milliammeters, ammeters, voltmeters and other units.

(45) ELECTRICAL CONTACTS AND ASSEMBLIES—P. R. Mallory & Co., Inc., 3029 E. Washington St., Indianapolis 6, Ind. Catalog, 60 pp, Contains many line drawings, photographs and descriptions, charts and tables, and gives a description of the many types of contact materials, their applications, and the advantages of each. Aids in the selection of the proper contact material for any application, presents detailed assistance toward design of contacts and contact assemblies in economical and practical forms.

(46) HIGH STRENGTH STEEL—Bethlehem Steel Co., Bethlehem, Pa. Catalog 353, 66 pp. Describes the properties and features of Mayari-R steels and their advantages in the manufacture and wear and corrosion-resistant properties in industrial equipment and equipment for the construction industry; in bridges; pipe; and in mining, transportation, and marine construction. Contains many drawings showing the cold form shapes and

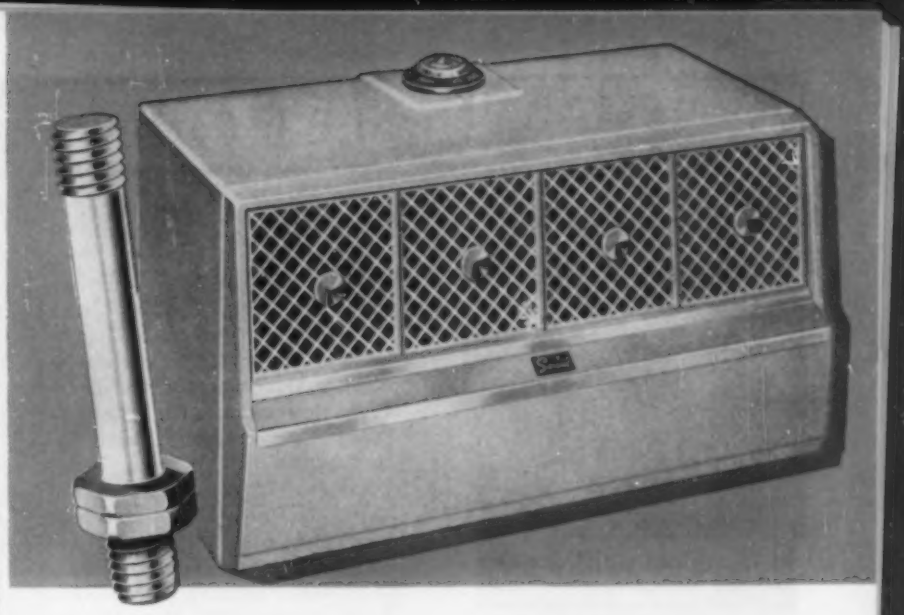
many illustrations. Also has a number of graphs and charts, plus pictures of corrosion test specimens, showing the various characteristics.

(47) VARIABLE PITCH SHEAVES — Speed Selector Inc., 18-V Noble Court, Cleveland 13, Ohio. Bulletin, 8 pp, gives typical applications of sheaves on various types of machines and power-driven equipment. Dimensional drawings and charts provide the necessary engineering data on sheaves available in seven standard sizes from 3 to 8 in. od. Capacities range from ¼ up to 15 hp. One full page is devoted to combination sheave size selection tables; another is a chart on belt length center distances.

(48) WELD FASTENERS — Penn Engineering and Mfg. Co., Doylestown, Pa. Catalog describes self-locating weld fasteners of steel and stainless steel. These fasteners which provide load bearing threads in sheets too thin to thread, are designed to eliminate burn-outs in thin sheets, complicated electrodes and pilots, indexing and retapping to remove weld splatter. Catalog shows design features which overcome these common shortcomings and gives pertinent specification data.

(49) CAST BRONZE & COPPER PRODUCTS—The American Brake Shoe Co., 4930 Manchester Ave., St. Louis 10, Mo. Booklet J-4515, 24 pp. Has illustrations showing the many cast bronze and copper products for general industry, also offers an alloy chart listing the composition, analysis, properties, and applicable specifications for copper, babbit, bronze, and aluminum alloys. Performance characteristics and specific product uses of the alloys are listed in a casting guide section.

(50) MINIATURE COMPUTING DIFFERENTIAL — Ford Instrument Co., Div. of Sperry Corp., 31-10 Thomson Ave., Long Island City 1, N. Y. Bulletin, 2 pp, illustrates and describes a new ⅛ in. mechanical computing differential, the latest and smallest addition to this firm's line of ultra-precision single spider gear differentials. The unit performs additive and subtractive operations in a working circle of 1.000 in. max dia. Data on speeds, temperatures, and construction are provided, as well as performance curves and detailed specifications.



Townsend Saves Servel $14,624 On Part For Electric Room Air Conditioner

The many luxury features you enjoy with Servel's electric room air conditioner stem from careful attention to every detail of design and assembly. This enables Servel to provide the benefits of better health and greater comfort in an efficient, moderately priced unit.

This is possible because no part is too small to be thoroughly analyzed as to function and cost. For example, the part shown here is one of the reasons for the efficient assembly of the unit. Four of them are used to mount the compressor, hold it securely in position to help assure smooth, quiet performance.

Until a Townsend engineer devised this improved part, Servel used an expensive machined part. It was cut from a hexagon bar, tapped to receive a bolt which was held in place by a lock washer.

The part as redesigned by Townsend is made in one piece by cold-forming—threads are rolled for greater strength and accuracy. The bolt was eliminated and replaced with a nut and lock washer in the assembly. Scrap loss was cut to virtually zero. The Townsend part is stronger and just as accurate. Annual savings amount to $14,624. Servel effects a big reduction in overall costs—at the same time produces a unit that is jam-packed with quality and performance.

This is merely one example of how the Townsend method of producing fasteners and small parts saves thousands of dollars annually for cost-conscious manufacturers in many industries. On material alone, other companies save from $3.00 to $125 per thousand pieces—have reduced assembly time and improved their products as well.

In addition to making the best possible products, Townsend has the versatility to produce regularly more than 10,000 special and standard types. It has the capacity to produce these items in tremendous quantity—60 million every day.

This all adds up to why Townsend has become known as "The Fastening Authority"—a reliable source of quality fasteners at reasonable cost. To learn more about the possibilities of new economies in your operation, write for Bulletin TL-89. Or send samples or sketches of the parts you wish improved and we will have one of our engineers call to discuss your problem.

Townsend

COMPANY • ESTABLISHED 1816

NEW BRIGHTON, PENNSYLVANIA

Sales Offices in Principal Cities

Cherry Rivet Division • Santa Ana, California

THE FASTENING AUTHORITY—Experience: *over 138 years*—**Capacity:** *sixty-million parts daily*—**Products:** *over ten-thousand types of solid rivets–cold-headed parts–Cherry Blind Rivets–Twinfast Screws–self-tapping screws–tubular rivets–locknuts–special nails–formed wire parts.*

Plants: *New Brighton, Pa.—Chicago, Ill.—Plymouth, Mich.—Santa Ana, Calif.*

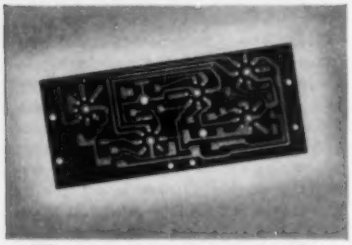
In Canada: *Parmenter & Bulloch Manufacturing Company, Ltd., Gananoque, Ontario*

SYNTHANE

laminated plastics at work

In chemical applications
Synthane's chemical-resistant properties, smooth surface, and durability are valuable to the photographic industry. Synthane components are used in preparing and developing sensitive films.

In electrical applications
Numerous insulating parts made of Synthane are used in radio and TV sets. Synthane supplies dielectric strength, the ability to resist elevated temperatures and excellent insulation resistance.



Where many properties are needed Synthane is a favored base material for p.inted circuits. It has chemical resistance to resist etching acids, dielectric strength, dimensional stability and it bonds securely with copper foil.

What's your PROBLEM?

MAIL COUPON FOR FREE FOLDER

Our 25th Year
SYNTHANE CORPORATION
4 River Road, Oaks, Pa.
Please send me your free folder describing advantages, properties, uses and kinds of Synthane plastics.
Name_____
Title_____
Company_____
Address_____
City_____ Zone____ State____

MEETINGS

June 20-24

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS — Semi-Annual Meeting. Hotel William Penn, Pittsburgh, Pa. Here is a list of the various technical sessions, and in parenthesis the number of sessions devoted to that subject throughout the week. Instruments & Regulators (2); Power (5); Machine Design (4); Heat Transfer (5); Gas Turbine Power (4); Metals Engineering (5); Rubber & Plastics (2); Fuels (2); Lubrication Activity (including aviation) (3); Production Engineering (4); Metal Processing (3); American Rocket Society (2); Materials Handling (2); and Management (2). A variety of plant tours are also available.

June 21-24

INSTITUTE OF AERONAUTICAL SCIENCES—IAS Building, 7660 Beverly Blvd., Los Angeles, California. The Annual Summer Meeting.

June 21-25

SUMMER AND PACIFIC MEETING OF AIEE—Hotel Biltmore, Los Angeles. Will show latest developments in nucleonics, computers, power generation, and others. The technical program will feature presentation of 200 papers at 48 sessions.

June 21-25

MASSACHUSETTS INSTITUTE OF TECHNOLOGY—Cambridge, Mass. A special one-week summer program in corrosion, to summarize the fundamentals and recent advances in this field. Discusses proper selection of materials; chemical treatment, selection of coatings and alloys, practice of cathodic protection, corrosion testing. Tuition for course is $100.

July 13-15

WESTERN PLANT MAINTENANCE SHOW—Los Angeles, Pan Pacific Auditorium. Solutions to maintenance problems peculiar to Pacific states industrial operations will be emphasized. At the opening session the discussion will be on maintenance organization, management, planning scheduling and training personnel. The balance will be a series of section conferences.

July 27-28

INTERNATIONAL UNION OF THEORETICAL AND APPLIED MECHANICS—4th General Assembly, Brussels, Belgium. Address gueries to: Dr. Hugh L. Dryden, 1724 F Street, N. W., Washington 25, D. C.

Aug. 23-Sept. 3

MASSACHUSETTS INSTITUTE OF TECHNOLOGY—Cambridge, Mass. A two-week special summer program in The Automatic Control of Machine Tools. Morning Sessions will be devoted to studies of systems and components. Afternoon sessions will cover programming techniques, using the numerically controlled milling machine developed in the servomechanisms laboratory. Tuition for the two-week course is $160.

Aug. 25-27

WESTERN ELECTRONICS SHOW & CONVENTION—Los Angeles Pan-Pacific Auditorium. The show and convention are sponsored by The West Coast Electronic Manufacturers Association and The Los Angeles and San Francisco sections of the Institute of Radio Engineers.

Aug. 30-Sept. 3

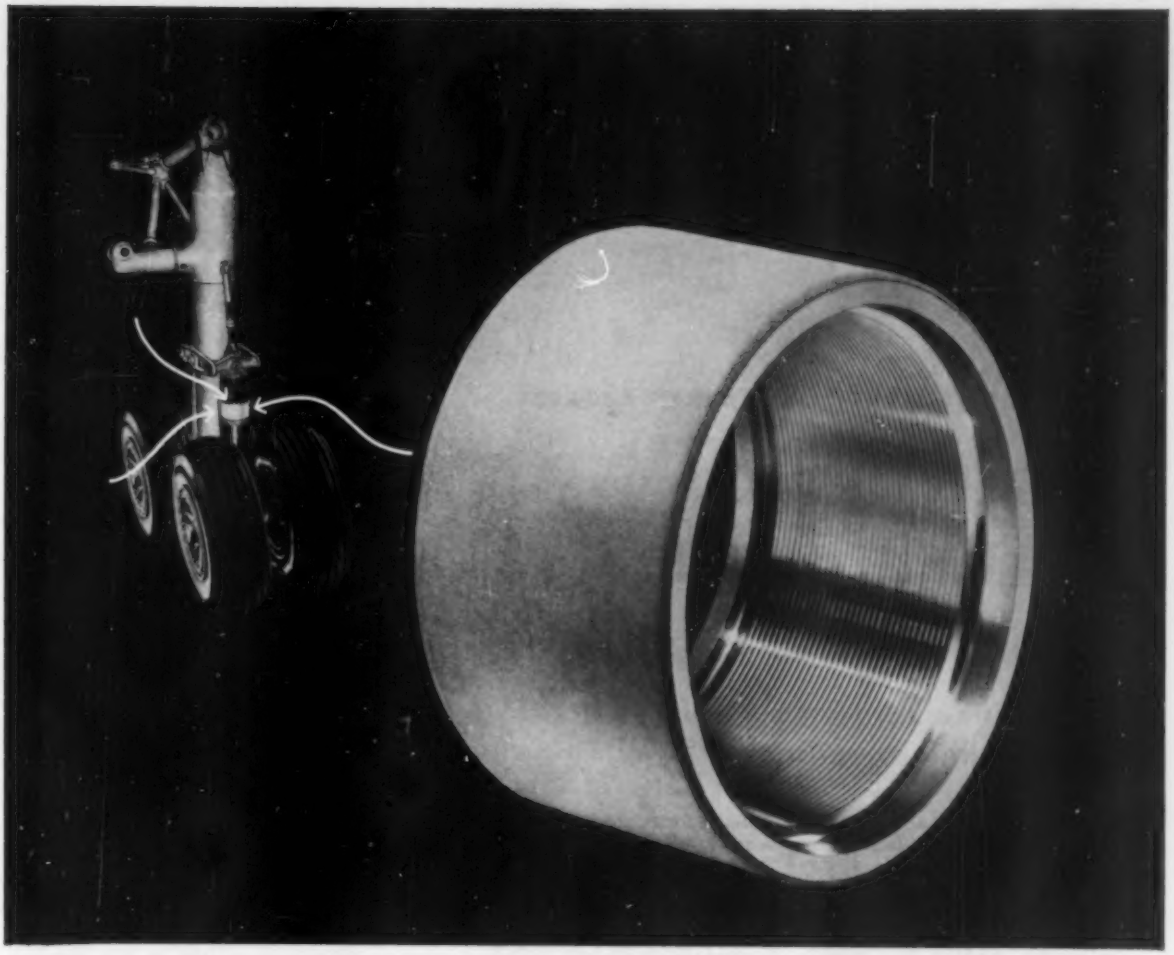
SIXTY-THIRD ANNUAL CONVENTION & TRADE SHOW OF THE PHOTOGRAPHERS ASSOCIATION OF AMERICA—Conrad Hilton Hotel, Chicago, Ill. Theme of affair is the rapid growth of photography as a tool of industry. Print exhibits, demonstrations, and discussions on newest techniques.

Sept. 1-16

INTERNATIONAL ELECTRO-TECHNICAL COMMISSION—University of Pennsylvania, Philadelphia, Pa. The Golden Jubilee Meeting. The commission seeks a better understanding between electrical engineers of various countries with common means of expression and standards for electrical machinery and apparatus.

Sept. 13-25

FIRST INTERNATIONAL INSTRUMENT CONGRESS & EXPOSITION—Philadelphia, Pa. Technical sessions will run through this period, while the exposition will open on Wednesday the 15th. Eight technical societies are cooperating with the Instrument Society of America in arranging the meeting.



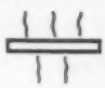
Final Approach to an Easy Touch-Down

Properties of Synthane

In addition to those mentioned in the text, Synthane has the following important properties:

Chemical resistance. *Synthane* resists most acids and alkalis in moderate concentrations. It is also resistant to corrosive atmospheres.

Low moisture absorption. Most grades of *Synthane* are highly moisture resistant. Special grades are available for applications where absorption must be at a minimum.



Thermosetting. *Synthane* will hold its shape under elevated temperatures. It cannot be reheated and reshaped; once formed it is permanent. (If post-forming is essential, special grades are available.)

Availability. In addition to more than 33 grades of sheets, *Synthane* is also supplied in many grades of rods, tubes and special shapes. Molded-laminated and molded-macerated parts are also manufactured. A complete fabricating service is available.

● A major problem in aircraft design since the very beginning has been proper landing gear. The Wright brothers used rigid, sled-like runners. For many years shock cord—giant-sized rubber bands—took up the load. As planes grew larger and landing speeds climbed, the modern air-oil shock strut was developed. An important component in the largest landing gear struts now made is *Synthane*—a laminated plastic.

The pistons used in shock struts must be tough, mechanically strong, shock-resistant, machinable, light in weight, impervious to oil, long-wearing and non-scoring. They must bond securely to aluminum cores. Dimensional stability is necessary over a wide range of operating temperatures. *Synthane* supplies all of these needed properties.

There are hundreds of applications for *Synthane's* electrical, chemical and mechanical properties. More than 33 different grades of this versatile laminated plastic help to fulfil a variety of specifications. If you have need of a material with many different properties in combination, *Synthane* may be your answer. Our catalog supplies full information about *Synthane* sheets, rods, tubes, and fabricated parts. To get your copy, please write us. Synthane Corporation, 4 River Road, Oaks, Pennsylvania.

Our 25th Year

SYNTHANE CORPORATION, OAKS, PA.

SYNTHANE

LAMINATED PLASTICS

wider and wider use

PEARLITIC MALLEABLE CASTINGS

as engineers become aware of its many advantages

DESIGN ADAPTABILITY: Because of its good fluidity, it can be cast in thin sections and in complicated shapes.

HIGHER STRENGTH: Ultimate strengths range between 60,000 and 90,000 psi; yield strength between 40,000 and 70,000 psi.

EASILY MACHINED: Machinability index (B1112 Steel = 100) ranges between 80 and 90.

WEAR RESISTANCE: Withstands excessive wear under heavy loads at high speeds.

LOCALIZED HARDENING: Sections of the casting can be flame hardened or induction hardened before or after machining.

BEARING PROPERTIES: Good non-seizing properties in metal-to-metal contact.

FINE FINISH: Can be given a very smooth finish where desired.

You will find many applications for Pearlitic Malleable castings – particularly as a replacement for forgings, stampings and weldments – where reduced weight, less machining time, fewer assembly operations and better appearance are important production and sales considerations. A-9264

NATIONAL MALLEABLE AND STEEL CASTINGS COMPANY

Cleveland 6, Ohio

The Nation's largest independent producer of malleable and pearlitic malleable

Ad Libbing by the Editor

Not long ago I had an interesting time listening to Doctor James Prier of Syracuse University explaining some of the mysteries of the human body. More than 90 percent of the adults have had polio, he told me. When I asked him how that was determined he told me that blood analysis revealed the remains of the anti-biotics that had killed off the polio germs.

Now I would not be surprised to learn that I have slight twists on some of the medical terminology and explanations, just like a news reporter gets his engineering all twisted. But I am certain that the statements as I have given them are substantially correct. In other words, any and every disease with which an animal body must contend, leaves its mark. The mark may be scars, lesions or the evidence of germs.

To some extent, there has been developed in engineering quite a few methods of analysis or tests that will reveal the conditions to which a material has been subjected. Photomicrographs, etchings and hardness tests often tell interesting stories. Leuder lines, evidence of stress corrosion, and fatigue cracks give clear indications to a trained observer.

Discolorations sometimes tell the temperature to which a part has been subjected. Tempers, scale or plastic flow may tell the same kind of a story. Hardness readings over the longitudinal cross-section of a piston will establish the paths of heat flow.

Presumably there are many more detectable and measurable properties that reveal the history of a material part. But I wonder if the medical profession is not a few steps ahead of engineering in the ability to diagnose.

Satisfactory Wear

Recently I heard a slogan credited to a General Motors research executive, "Our job is to design products to wear out to our customers' satisfaction." Many a great truth is spoken in jest, and that remark is an example. It also

reminds me of a talk I had with the late Joseph Ledwinka, for many years chief engineer of the Budd Company.

"When will automobile bodies be made of aluminum?" I asked him.

He answered with the question, "Why should automobile bodies be made of aluminum?"

"There are two good reasons," I had the temerity to say. "In the first place, the lighter weight will save gas. Secondly, an aluminum body won't rust."

"American automobilists don't care much about the amount of gasoline they use, nor do they want their auto body to last much more than five years. The American automobile owner is always looking for an excuse to buy a new car and is not happy to ride in a car that looks out of date. The average auto owner would not like it if his car body did not wear out reasonably soon and thereby give him a good excuse to buy a new car."

In other words, the auto body that wears out in seven or eight years, wears out to the customer's satisfaction. Another point of view is that the product should "wear out all over at the same time," just like the one-horse shay.

Beware of Superlatives

Recently in a speech a man stated that, "There is only one reason, and one reason only, why a man buys a given machine or piece of production equipment. He buys the machine that will produce the most."

Superficially, that sounds like a true statement. Actually, the statement is greatly over simplified. The physical size of the machine, the cost of maintenance, the degree of precision to which it can produce, its flexibility, the amount of skill required to operate it, and many other factors must be considered if the machine is being bought with any degree of intelligence.

In addition, it often becomes painfully obvious that it is impractical or impossible for an operator to get the rated production out of a machine. The chief engineer of a machine tool company told me this story as he was showing me a new model machine.

"The first one of these that we sold did not do so well. We had correctly figured feeds and speeds and properly allowed for putting in and taking out. Yet the customer to whom we sold the first machine claimed it could not produce half of what it was

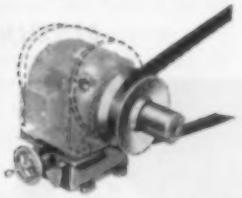
REEVES

Vari-Speed Motor Pulley

Smaller Units!
More HP!

Completely new redesigned line from ½ to 15 HP!

"spiral-groove" lubrication



For new or old NEMA Motors

CHECK ALL THESE NEW REEVES FEATURES

1 New, smaller disc assemblies are engineered for new NEMA Motors, yet usable with old.

2 New spiral-groove lubrication assures complete lubrication for years of rust-free, trouble-free service.

3 One-point lubrication. Unit can be lubricated when stopped, or *while in operation.*

4 Superior base construction provides greater rigidity and strength, reduces vibration and noise.

REEVES PULLEY COMPANY • COLUMBUS, INDIANA

Write for complete details and new bulletin today!
Specify Dept. K8-V545.

NEW!

Laminated Shims of Aluminum

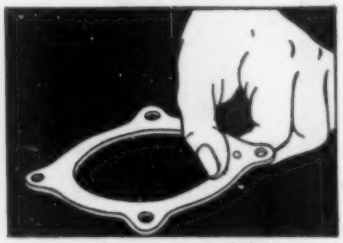
with all laminations surface-bonded

This new type of laminated shim brings you all the advantages of aluminum — light weight, freedom from corrosion and electrolytic action — in shims that P-E-E-L quickly and smoothly for adjustment. They're bonded over their entire surfaces and are made just as carefully and expertly as the brass and steel laminated shims we've been producing for over 40 years.

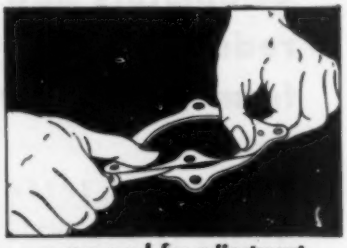
Laminated aluminum is available either as shims custom-stamped to your blueprint specifications or as laminated sheet stock in thicknesses from .015" to .125", sizes to 20" x 48". Stocks are maintained on both the East and West Coasts.

For free sample of material, further information and prices, please write us direct.

ALUMINUM LAMINATED SHIMS



they look "solid"



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supposed to do, according to the specs.

"We went over all the figures again, and they checked. So we told our sales manager the customer was probably not using the right feeds and speeds. The next day the sales manager asked me to go to the customer's plant and show them where they were wrong.

"I did. And what a time I had. In a half hour I did manage to produce 43 pieces, and the machine was sold to do 85 an hour. So on the face of it the machine produced up to expectations. But by the time the half hour was up I was sweating like a bull, my tongue was hanging out and my knees were shaking. I guess I must have stretched, jumped and skipped around a distance of a hundred yards in less than 10 seconds flat to reach all the levers, controls and push buttons. What a time I had.

"Of course we got on the job right away and rearranged all the controls so that the operator could reach them all without moving a foot. And then the machine produced to its rated capacity."

In most instances there are several or many factors that contribute to a given end result or features. Indeed, often it is impossible to list all of the causes and influences that entered into a given result. What are the factors that make the stock market go up or down, that affect the results of an election, that cause war, victory or defeat, that establish a foolish public whim such as chain letters, that make an idol out of a public character whose name might be Hitler, Mussolini, Tito, or Huey Long?

If man had the limited brain power of a mosquito, beetle and June bug, his actions and operations would conform consistently to given formulas. It would then be possible to figure out human reactions exactly. But of course man will never be able to do it because if he were dumb enough to behave consistently he would not have the brains to figure out what he would do in response to a given impulse, stimuli or action.

Thus it is that man is cursed never to be able to figure himself out. He is too intelligent to react consistently the same to a given impulse, and if he were so unintelligent that his actions did respond always the same way to any given impulse, he would be too stupid to be able to figure it out. How dumb it is. —G.F.N.

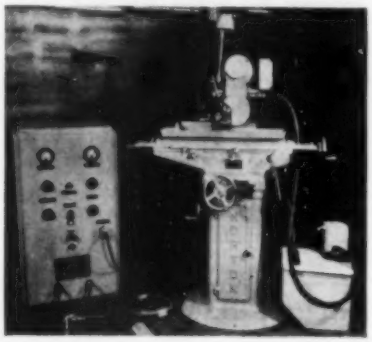
ENGINEERING ABSTRACTS

Electrolytic Grinding

Abstracted from "Electrolytic Grinding—Its Status and Future" by George Comstock, Research Engineer, Norton Company, Worcester, Massachusetts. Presented at the 18th Annual Machine Tool Electrification Forum, sponsored by the Westinghouse Electric Corporation, at Buffalo, N. Y., April 6 and 7, 1954.

ELECTROLYTIC GRINDING is a process of stock removal in which conventional grinding is accompanied by a simultaneous electrochemical decomposition of the work material. The electrolytic part of this operation is essentially an electroplating process in reverse.

The basic prerequisites of the method are these: the work material, the grinding coolant, and the grinding wheel must all be electrical conductors; and direct current must be passed between work and wheel. The simplest circuit suitable for electrolytic grinding is a battery supplying current to the grinding interface through a series limiting resistor, which would control



short-circuit current. The work is the positive pole, and current is passed from work to wheel by a thin film of electrolyte carried between the two by the motion of the wheel. To date, the electrolytic grinding method has found application almost exclusively in the sharpening of single point tools—a job normally done with diamond grinding wheels. The rate at which metal is removed by electrolysis at reasonable current densities is low compared with most machining operations.

The amount of abrasive action required from the wheel is considerably reduced, but some abrasion is required

Standardizes on NORDBERG Diesel Light Plants for 1400-DE Shovels

The P & H Model 1400-DE Diesel Electric Crawler Mounted Shovel recently announced by Harnischfeger Corporation includes numerous advantages of interest to profit-minded contractors.

In keeping with their constantly high standards of quality, P & H are installing NORDBERG Diesel Light Plants as standard equipment on the Model 1400-DE shovels.

These Nordberg Diesel Generator units are compact, heavy duty, one-cylinder 4½" bore x 5¼" stroke engines, direct connected to 6 K.W. generators — providing ample capacity for the powerful lights used in "around-the-clock" operations.

Built in 1, 2 and 3-cylinder models, these reliable, low cost Nordberg Diesels are available as power units in sizes from 10 to 45 hp; as generator sets from 6 to 30 K.W.; and as pumping units in capacities from 200 to 3,000 gpm at 15 to 240 ft. total head.

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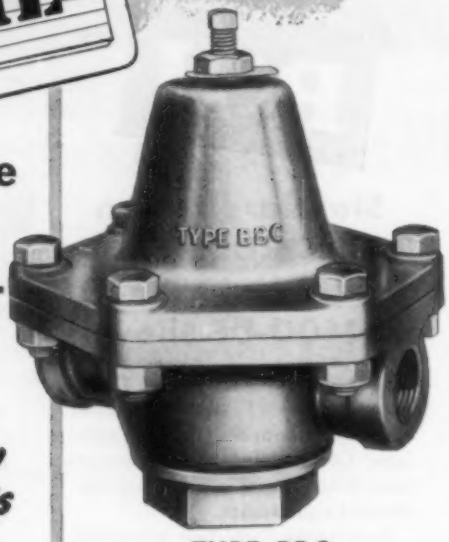

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Here's a direct acting, single seated, diaphragm-type pressure reducing and regulating valve that automatically reduces a high pressure to a specified lower pressure and keeps it there. Type BBC is for heavy oil service, such as on installations carrying Bunker "C" and other grades, as well as for service on installations where dirty liquids or fluids with a high viscosity are employed. Maximum initial pressure *in iron*, 200 psi; maximum reduced pressure *in iron*, 125 psi. Maximum initial pressure *in bronze*, 250 psi; maximum reduced *in bronze*, 200 psi.

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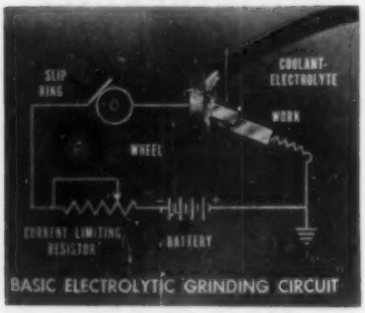


BASIC ELECTROLYTIC GRINDING CIRCUIT

to remove the products of decomposition, which would form an insulating barrier if allowed to remain.

Since the rate at which work may be turned out by an electrolytic grinding process is little different from the productivity of conventional grinding, labor cost is little affected. On the other hand, wheel wear for the two operations shows a decided advantage for the electrolytic method.

Higher current densities yield greater output, but only by increasing the voltage which increases the tendency arc. Arcing not only produces rough surfaces on the work but causes high wheel wear. Three methods used to control arcing are: a resistor in series with the power source which also increases the power loss and safety hazard; a constant-voltage current-limit system which has less safety hazard; and an electronic current-control circuit sensitive to the electrical noise in the load circuit generated by incipient arcing. Norton uses the second of these methods, the constant-voltage current-limit arrangement, with a two-stage magnetic amplifier to control the power.

Electrospark Machining

Abstracted from "Electrospark Machining —Metal Removal Without Contact" by C. Paul Porterfield, Vice President, Method X Company, Pittsburgh, Pa. Paper presented at the 18th Annual Machine Tool Electrification Forum, sponsored by the Westinghouse Electric Corporation, Buffalo, N. Y., April 6 and 7, 1954.

SINCE THE FIRST CRUDE WEAPON was fashioned by man, he has always machined materials by subjecting them to mechanical force applied by using a harder material as a tool. In machining it is necessary to impart motion either to the tool or the work and then with physical effort force the tool against the work so as to detach portions of the workpiece. This force is supplied

DOW CORNING

Silicone News

No. 7 of a Series • PUBLISHED BY DOW CORNING CORPORATION, MIDLAND, MICHIGAN

NOW--SILASTIC RTV--NEW DOW CORNING SILICONE RUBBER THAT VULCANIZES WITHOUT HEAT

Silicone rubber that vulcanizes without heat—that's the big news from our product development laboratories. Known as Silastic RTV (Room Temperature Vulcanizing), this new type of silicone rubber develops excellent high and low temperature stability, water repellency and chemical resistance within 24 hours after application.

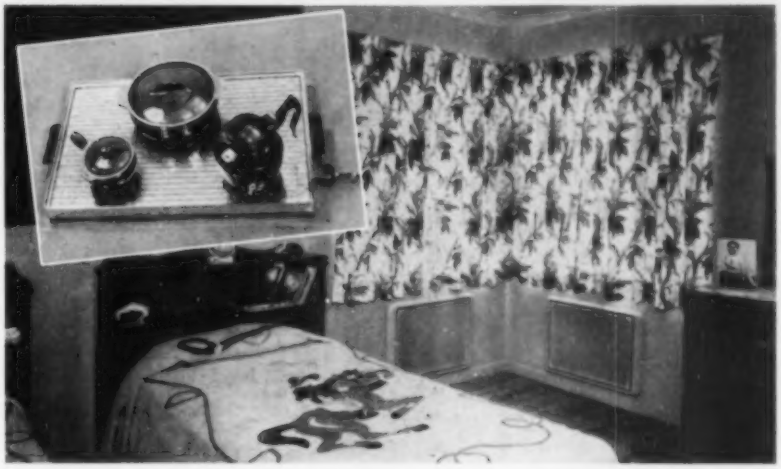
The properties of Silastic RTV, outlined in Table I, suggest its usefulness as a cloth dope; as a caulking, glazing and sealing material; as a potting and encapsulating compound for electric and electronic assemblies; and as a casting compound for making flexible molds. Costwise, Silastic RTV is comparable to standard Silastic stocks and pastes.

TABLE I
Typical properties of Silastic RTV after curing in ⅛ inch sections

Durometer (Shore A)	15-30
Tensile Strength, psi	130-150
Elongation, %	300-600
Moisture Absorption after 7 days @ 70 F, %	1-2
Dielectric Strength, vpm	350-550
Dielectric Constant	
100 cycles	3.2-3.4
1 megacycle	3.0-3.2
Power Factor	
100 cycles	.015-.030
1 megacycle	.005-.01

Silastic RTV is available in several consistencies with each supplied as two separate components. When the two are mixed in

(continued pg. 2)



Silicone Paint Enables Designers To Perfect Glass Radiant Heating Panels

Design engineers for the Blue Ridge Corporation of Kingsport, Tenn., learned how effectively Dow Corning Silicones can be used to make a radically new idea practical. One of their projects was to produce a radiant heating panel by bonding a bare strip heater to plate glass.

But efforts to realize that basically sound and simple device were frustrated by lack of a sufficiently heat-stable insulating material that would bond to the panel. This problem was finally solved, however, through use of a silicone paint possessing the necessary chemical resistance, heat stability and dielectric properties.

In manufacturing the panels, metallic aluminum is applied to a heated plate of tempered glass. Ribbon-like strips of silicone paint are then applied over the aluminum surface through a silk-screen. The panel is then immersed in a caustic bath which etches away the uncoated aluminum leaving only the silicone coated ribbon to which terminal clips are attached. The ribbon becomes a fully insulated electrical element in a "Ra-grid Plate," capable of generating and maintaining temperatures as high as 200 C.

Evidence of the practicality of the "Ra-Grid Plate" is the fact that over a quarter of a million of these units have been produced to date. They are used in military, public, industrial and private buildings as "Glassheat" wall heaters made by the Continental Radiant Glass Heating Corporation. That company describes them as the cleanest, safest and most economical space heating system in existence.

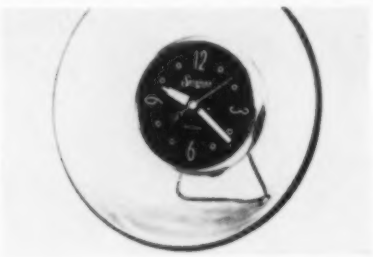
The Salton Manufacturing Company also uses the "Ra-Grid Plate" in their distinctive and efficient food warmers and heated serving trays marketed under the trade names "Hotables" and "Hotrays".

Tests show that prolonged operation at maximum temperatures does not reduce the

(continued pg. 2)

Silicone Oils Make Time Pass More Quietly

It is a well established fact that light silicone lubricants increase the service life and help to maintain the accuracy of the small synchronous motors used in timers for clocks, washing machines and dryers, oil burner controls and refrigerator defrosters.



Another sales feature of these silicone oils has recently been reported by the Sessions Clock Company of Forestville, Connecticut. They say, that, even after years of operation Sessions silicone lubricated clocks are so quiet that a blind-folded person can instantly tell the difference between a Sessions clock and all other clocks! **No. 57**

FOR DATA RELATING TO THESE ARTICLES, CIRCLE REFERENCE NUMBER IN COUPON ON NEXT PAGE

MORE

DOW CORNING Silicone News

NEW DEVELOPMENT AND TECHNICAL DATA

For copies of any of the publications reviewed in this column or for data relating to any of the articles printed in this issue of the Dow Corning Silicone News, simply circle the corresponding reference number on the coupon below.

Dow Corning 7 Emulsion, a water dispersible silicone release agent, is effectively used in the rubber, plastics, plywood and metal fabricating industries. For data on its properties, uses, and application methods, check reference *No. 61*

●

"Industrial and Laboratory Evaluation of a Silicone Protective Cream", is a clinical report on the effectiveness of a skin cream made with Dow Corning silicones against dermatitis resulting from contact with industrial irritants and sensitizers. Reprints are now available. *No. 62*

●

Use of bare magnet wire coated with new Dow Corning Wire Enamel permits operation of small electric machines and electronic parts at 180 C. Flexibility, scrape hardness and dielectric strength compare favorably with those of the best organic wire enamels. Life expectancy at 180 C is in the range of 50,000 hours compared with 200 hours for wire insulated with conventional enamels. *No. 63*

●

This is the first offering of a new data sheet that describes the properties of parts fabricated of various Silastic stocks and pastes. An up-to-date summary, it includes all of the Silastic stocks now available in commercial quantities and lists typical properties of each. It is a convenient reference guide for designers concerned with the selection and use of silicone rubber parts. *No. 64*

●

"What's a Silicone?" is the title of a 32 page booklet which answers that often asked question in semi-technical terms. Indexed and illustrated, this booklet has earned an international reputation as the most interesting and informative description of silicones ever published. *No. 65*

●

In a recently published article entitled "Uprating Horsepower With Silicone Insulation", the performance characteristics and the factors that must be considered in uprating motors by rewinding with silicone (Class H) insulation are summarized. Several case histories describe how industrial motors have been successfully uprated to deliver 50 to 75% more horsepower. *No. 66*

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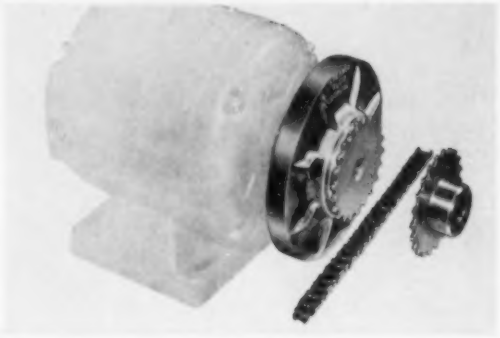
Silicone Fluid In Simplified Fluid Coupling Assures Uniform Performance Over Wide Temperature Range



The Sterner fluid coupling recently introduced by L & S Industries of Norwalk, California, depends upon the inherent stability of Dow Corning 200 Fluid to assure smooth acceleration of inertia loads regardless of operating temperatures.

Surpisingly low-priced, the coupling can be installed in a matter of minutes. No extra couplings, shafts, sheaves, or bearings are required. The coupling is also self-lubricating, and designed to eliminate the need for replaceable seals. Consequently, no maintenance is required.

When stationary, the fluid level is below shaft level. Motion forces the fluid to the periphery of the housing which is of welded construction to prevent leakage of fluid. And because the silicone fluid does not evaporate or oxidize to form gums, one filling lasts the life of the unit.

Dow Corning 200 Fluids are used to accomplish many previously "impossible" improvements in design because they possess an unusual combination of properties including exceptional resistance to oxidation, to shear-breakdown and to changes in viscosity over a wide temperature span. For example, these silicone fluids made it possible to design the heavy duty torsional vibration dampers now used on diesel engine crankshafts and on several makes of automobiles.

In other damping applications including instruments, gauges and dashpots, the use of Dow Corning 200 Fluids increases accuracy and reliability and substantially reduces operating and maintenance costs. *No. 58*

NEW SILASTIC RTV *(continued)*

equal parts by weight, they form a self-vulcanizing system that will "set" in approximately 4 hours, cure in 24 hours and develop optimum properties after 4 to 7 days. Components for the more fluid consistencies can be mixed by stirring; the heavier ones may require a short milling to complete the mixing.

The working life of Silastic RTV can be extended by adding xylene or other suitable solvents to the components before mixing. Stored in closed containers, such solvent containing mixtures will remain workable for as long as three weeks. When exposed to air, they will cure within 2 days after setting and develop optimum properties in 6 to 7 days.

Sections of Silastic RTV up to one-eighth of an inch in thickness can be cured without heat, pressure or full exposure to air. Curing time can be substantially shortened, however, by heating at temperatures up to 300 F after the material has set. Sections between one-eighth and one inch in thickness may be cured at pressures up to 50 psi. *No. 59*

SILICONE PAINT *(continued)*

insulating and protective qualities of the silicone paint on the "Ra-Grid Plate". In actual use, failures have been so rare as to be considered negligible. *No. 60*

First in Silicones

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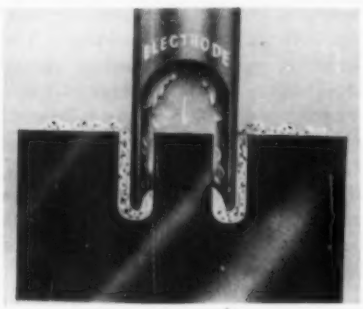
LARGEST PRODUCER OF: *SILICONE* Fluids • Abhesives • Adhesives • Release Agents • Compounds Greases • Water Repellents • Bonding Resins • Electrical Insulating Resins Molding Compounds • Expansible Resins • Defoamers • Silastic

by electric power supplied to a motor which converts the electrical energy into mechanical energy and motion.

Applying electrical energy directly to the removal of metal is not new. Joseph Priestly in 1786 conducted experiments on the erosive efforts of a spark discharge. Recent exploitation of such methods has been encouraged by problems encountered in machining sintered carbides.

Electromachining is developing in three directions: contact-initiated discharge, electrolytic, and spark-initiated discharge. The first of these processes utilizes a low-voltage high-current a-c source connected between the tool and work. Since the power source is low voltage the tool must touch the work to initiate current flow and start the machining action. When the tool touches the work a continuous a-c current flows with a magnitude limited by the impedance in the circuit; the tool is then withdrawn until an arc is



formed. During the arcing interval the temperature of a small area at the arc terminal rises, and if a coolant is applied to this area thermal shock causes small particles of the work to break away. This method of metal removal is most commonly utilized in so-called "tap extractors."

The second method, the electrolytic process, utilizes an electrolyte as a conducting medium and is often applied to a grinding or cutoff operation. Low-voltage direct current is applied between a rotating disc and the work while the work is covered by the electrolyte. The disc is made negative and the work positive. During the time that current flows, machining takes place at least in part as a result of electrochemical action. The electrolyte commonly utilized in this process is a solution of sodium silicate.

The third process utilizes the breakdown of a dielectric to initiate a spark

SKINNER V5-3 THREE-WAY SOLENOID VALVES

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Operates twice as fast!

COMPACT
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Skinner engineers have now added to Skinner V5-3 Series Valves a new feature that assures faster operation of machinery than is possible with Standard V5-3 valves. It's "Quick Exhaust" — achieved through utilization of pressure differentials and a quick exhaust orifice ⅛" in diameter. "Quick Exhaust" speeds up the return stroke of small air and hydraulic cylinders . . . boosts operating speeds.

Skinner V5-3 Quick Exhaust valves are three-way, normally closed. Their soft, synthetic plunger inserts and positive, spring-loaded operation assure leakproof performance — *through millions of cycles.* Bodies and internal parts are made of stainless steel. Moisture-resistant, varnish-impregnated coils are another quality feature.

Valves of this series are compact — precision-built yet rugged — designed and manufactured to give years of dependable service.

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Pressure Ratings.....50, 75, 100, 150 P.S.I.
Orifice diameters.....⅛", 3/32", 1/16", 3/64"
Secondary exhaust diameter.....3/32"
Pipe Size.....⅛" or ¼" NPT
Voltage.....All common AC, DC Voltages
Power Consumption.....9 Watts Maximum

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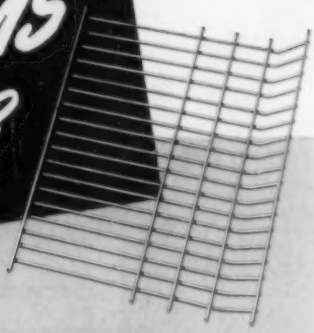

Had to Conserve Steel

Ice deflector assembly made by Company A for ice cube machines consisted of sheet steel, woven wire cloth and steel frame. Material shortages loomed. Told it to Titchener. Titchener designed this welded wire rack using one size of wire. New assembly proved to be sturdier — rustless — lower in cost. Additional dividends: simple tooling — fast large-scale production.
Note: Wire is more readily available during shortages. Can your product be made of wire? Ask Titchener.

Wanted Substitute for Casting

Company B, a stove manufacturer, was dissatisfied with breakage of its cast iron burner grates. Told it to Titchener. This Titchener welded-wire assembly was substituted. Result: No breakage — costs less.
Note: Wire is rigid, yet resilient. Light, yet tough. Stronger than castings or forgings. Wondering if wire can help you? Ask Titchener.

Design Was Difficult to Produce

Company C designed this complicated two-piece floor mop wire clamp. Ran into production difficulties. Told it to Titchener. Our skilled tool makers developed an ingenious method of coiling wire around itself. This made it possible to produce thousands of precision-made clamps at high speed on Titchener's forming machines.
Note: Titchener has worked hand in glove with all types of industry — large and small — in peace and war — for 65 years. How can Titchener serve you?

Tell it to TITCHENER!

If your problem involves wire forms, light stampings, welded-wire assemblies or wire-and-strip-steel items — Tell it to Titchener.

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Send us your prints — or describe your problem in a letter. Confidential. No charge for our suggestions.

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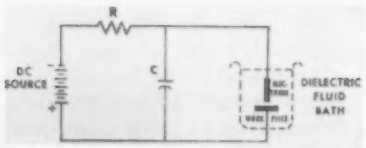

discharge and does not require the tool or electrode to touch the work to achieve machining efficiency. In fact, if the tool does touch the work is slows down the machining action. The mechanical structure need only be sturdy enough to support the tool and workpiece and position them to the desired accuracy. A brass tool will machine such materials as tungsten carbide, with a high rate of metal removal.

In its simplest form the electrospark machine resembles a drill press except for the dielectric tank at the base of the machine column which contains the table supporting the work. The voltage ranges from 75 to 400 volts, with higher voltages used for roughing cuts. Feed is usually accomplished through a servo-drive operating from the voltage between tool and workpiece. The capacitor is a rapid-discharge energy storage device with discharge potential determined by the distance between electrode and workpiece. The high current discharge dislodges particles of the material being machined. Discharge rates of up to 12,000 per sec, currents up to 50,000 amp with average power of 15 kw have been used.

In an inside machining operation chip removal presents the greatest obstacle to increasing machining speed. Normally chip removal is accomplished by using the liquid dielectric as a vehicle. Rates of metal removal attained in sintered carbides are a multiple of the rates achieved by standard machining. Removal of chips does not present a limiting factor in outside machining.

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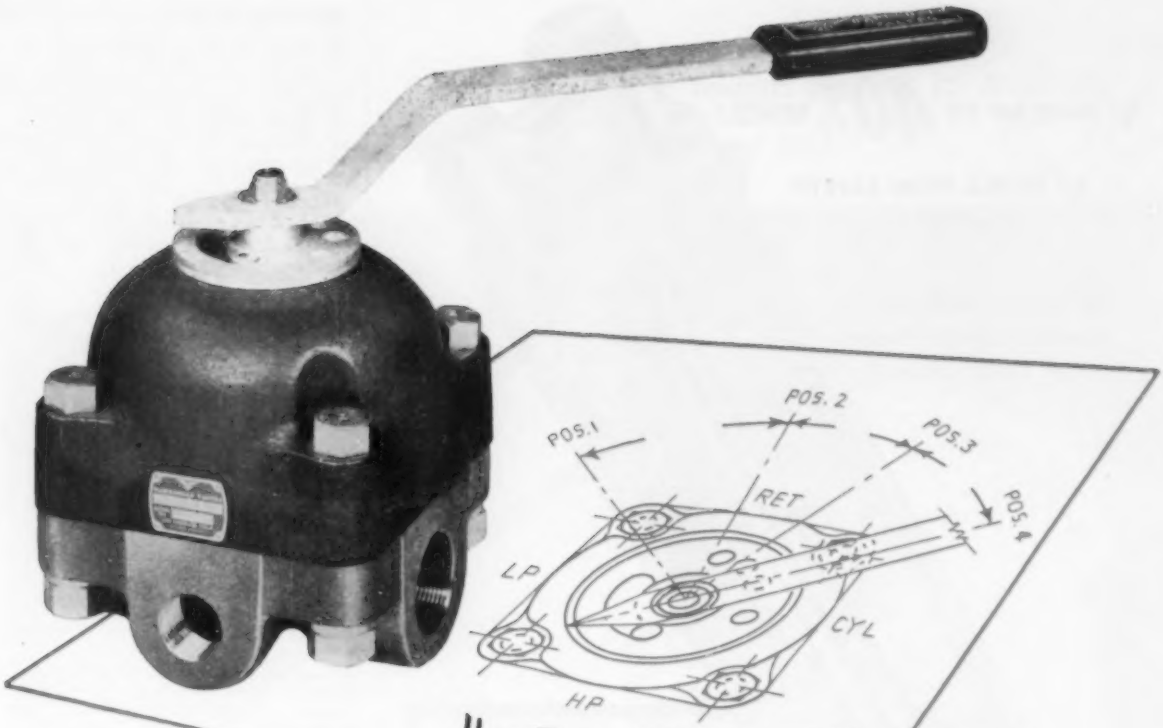
1. "An Account of Rings Consisting of All of the Prismatic Colors, Made by Electrical Explosions on the Surface of Pieces of Metal," Joseph Priestly, Phil. Trans. (Royal Society of London), Vol. 58, 1768, pp 68-74.
2. "Electro-Erosive Machining of Hard Metals and Carbides," I. Weber and G. F. Nordbloom. Report by Panel on New Processes for Machining and Grinding of Min-



Patent Pending

"Shear-Seal"

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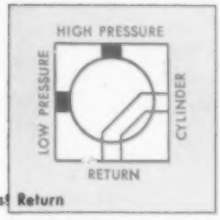
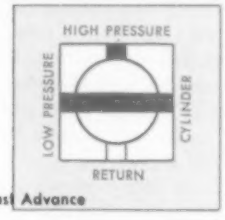
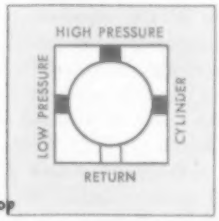
WATER AND OIL SERVICE TO 3000 P. S. I.



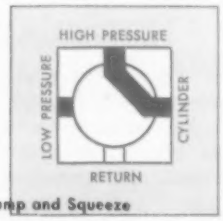
POS. 1: Fast Return



POS. 2: Fast Advance



POS. 3: Stop



POS. 4: Bump and Squeeze

Especially developed to improve the control of accumulator operated presses. Effortless manipulation of the valve, with one hand, puts the press under your absolute control (see flow diagrams). The first and second position provide *fast* "return" and "advance" with throttling in between for "inching" the press to any desired degree. The "stop" position gives the operator a chance to hold everything instantly, perhaps to *check* rather than *wreck* the dies. And finally the high pressure position serves for "bumping" and the "squeeze." The most important reason why such a maneuverable valve is possible, lies in the *leak-proof* feature of the Barksdale "Shear-Seal" principle and its characteristic improvement with use.

For more complete information write for bulletin BVM-2 describing the "Shear-Seal" principle and Catalog 3G covering the valves.

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RIVETORS, AIR AND HYDRAULIC CYLINDERS, CUTTERS, CLINCHORS

erals and Metals Advisory Board, Report #MAB-18-M, App. IX.

3. "Procede et Machine pour le Travel de Metaux," N. Lazarenko, B. Lazarenko, Swiss Patent 257468.
4. "Machine and Apparatus for Electrically Disintegrating Metal Material," E. Teubner, U. S. Patent 2,650,979.
5. "Theory of Electric Spark Machining," E. M. Williams, Trans. AIEE, Vol. 71, Part II, pp 105-108, 1952.
6. "Recent Developments in Theory and Design of Electric Spark Machine Tools," E. M. Williams, J. B Woodford, Jr., Richard E. Smith, Trans. AIEE, Vol. 73, 1954.

Reliability of Electron Tubes

Abstracted from "Military Reliability of Electron Tubes," by E. R. Jervis and J. Swauger, Aeronautical Radio, Inc., Washington, D. C., *Electronics,* April, 1954.

SEVERAL LONG-TERM PROGRAMS have been launched by the armed services with a view to improving the reliability of more than 30 tube types. These are usable in more than two-thirds of all sockets in present-day military equipment. The improved types are being developed to reach a goal of 95 percent survival in 1,000 hr operation in contrast with 80 percent in 500 hr for presently available tubes.

In two years, 88,500 tubes removed as defective by military technicians have been collected. Over 62,000 tubes have been installed in controlled tests. Tubes under test include more than 14,000 of the 22 improved tube types as well as many thousands of their JAN prototypes.

Most of the information concerns performance of JAN tube types since the improved versions have been used only in limited numbers during the last two years. It concerns the period from September 1951 through March 1953 and includes data from over 44,000 tubes collected from 44 general equipment types.

Types of Defects

Tube returns have been classified in four general defect categories. Electrical defects include tubes rejected because of deterioration of performance caused by faulty processing during manufacture, end of normal tube life

Molder: General American Transportation Corp., Chicago, Ill.

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Type 3	General Purpose Polystyrene
Type 7	Improved Heat Distortion Temperature
Type 8	Highest Heat Distortion Temperature
MC-185	"High Impact," Lowest Water Absorption Rate
MC-301	"High Impact" Improved Heat Distortion
MC-305	"High Impact," Easy Flow
MC-309	"High Impact," Highest Heat Distortion Temperature
MC-401	"Medium Impact," Improved Heat Distortion Temperature
MC-405	"Medium Impact," Easy Flow
MC-409	"Medium Impact," Highest Heat Distortion Temperature

• Westinghouse Electric wanted another liner for refrigerator doors—one that would be easy to clean, odorless, shock-resistant, and yet low in cost.

The molder, General American, suggested use of a liner made from a special, high-impact plastic. Koppers Modified Polystyrene MC-305 met the requirements, and is now used in several Westinghouse refrigerator models.

Koppers Polystyrenes, both regular and modified, have helped many manufacturers improve their products, and/or cut production costs. These plastics flow easily during molding, thereby reducing the molding cycle and increasing production. Our technical staff will be glad to assist you in selecting the specific Koppers Polystyrene that best fits your needs. Call or write your nearest Koppers office.

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and environmental or operation conditions. Mechanical defects are physical defects in the structure caused by environmental conditions or weaknesses of tube construction. Miscellaneous defects include broken glass, noise, microphonism and defects caused by unusual environmental conditions or mishandling by maintenance personnel. The no-defect category includes tubes removed by maintenance personnel, yet found upon laboratory examination to contain no mechanical or electrical defects.

One-third of all the tubes rejected from military equipment are not defective at all. An additional one-sixth of the tubes were probably damaged during installation or maintenance. The remaining 50 percent are truly defective. However, two-thirds of these failed only after progressive deterioration; they could have been located and removed before causing trouble. Therefore, only one out of every six tubes represents a failure such as would cause unpredictable equipment malfunction.

Deterioration Failures

The rate of decay of cathode emission is related to the residual gas in the envelope at the beginning of tube life. As time passes, the cathode absorbs some of this gas and is gradually poisoned. This process may be accelerated if additional gas is developed as a result of electrical overloading or high ambient temperature.

The evaporation of metal from hot elements in tubes produces gradual deterioration in the insulating properties of the tube structure and low-resistance paths between electrodes, resulting in noise or irregular operation. Methods for minimizing this effect are coating smooth surfaces with rough insulating material to increase the length of the leakage path, proper shielding of electrodes, elimination of getter material, use of non-evaporating getters and inactive alloys and limitation to minimum operating temperatures in all elements.

If tubes are operating under conditions of constant vibration and frequent shocks, gradual deterioration can occur as a result of the enlargements of the supporting holes in the mica spacers. Eventually the electrical output produced by mechanical movement of the parts will overcome the useful output of the tube. Corrective meas-

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The motor swing base (Fig. 1) as an example is made from steel plate and simple tubing. The components are tacked and then fillet welded with Manual Lincolnweld hidden-arc welding. Considerable finishing time is saved since welds are self-cleaning and the steel plate requires no filling before painting as when castings are used.

With Manual Lincolnweld, the cost of welding is reduced one-third over conventional welding with coated electrodes. Welds have high penetration and high ductility assuring top strength and dependability in service.

Fig. 1 Motor Swing Base is built up from components of tubing and steel plate. Photos Courtesy Dahlstrom Machine Works, Inc., Chicago, Ill.

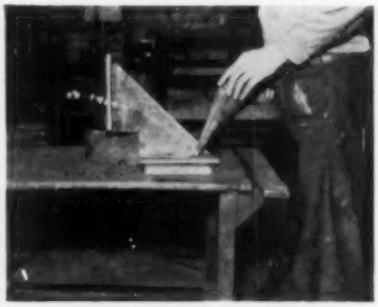

Fig. 2 Simpler Production Fillet welding of bracket for low cost manufacture. Manual Lincolnwelding in agglomerated flux eliminates arc rays and smoke.

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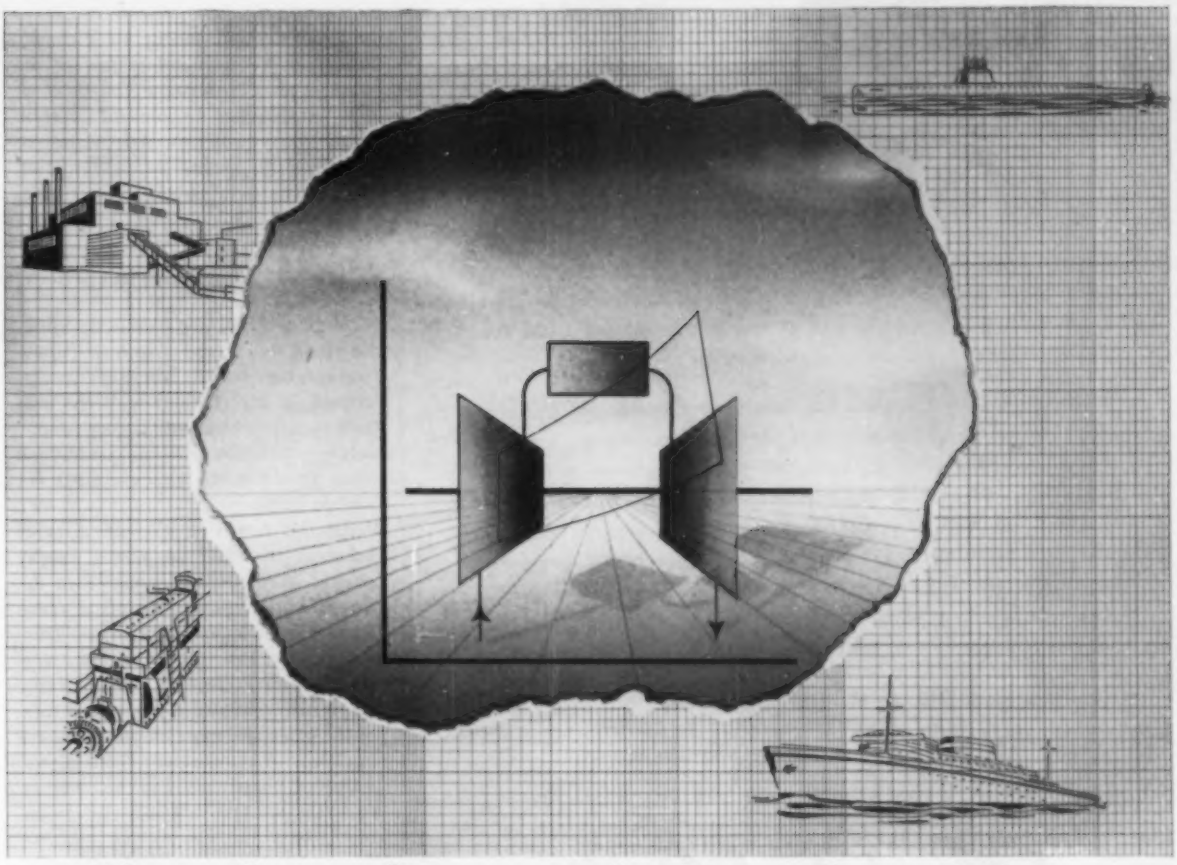

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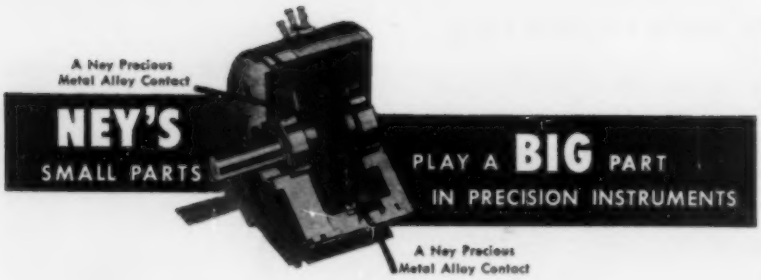

Illustrated above is a Helipot single-turn Model J Potentiometer using Ney Precious Metal Contacts. These contacts were designed to meet the special requirements of this instrument and assure the utmost in linearity and electrical output.

The J. M. Ney Company has developed a number of precious Metal Alloys and fabricates these into contacts, wipers, brushes, slip rings, commutator segments and similar components for use in electrical instruments. Ney Precious Metal Alloys have ideal physical and electrical properties, high resistance to tarnish, and are unaffected by corrosive atmospheres. Consult the Ney Engineering Department for assistance in selecting the right Ney Precious Metal Alloy which will improve the electrical characteristics, prolong the life and accuracy of your instrument.

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ures include anchoring all elements firmly, using close tolerances on the mica spacers, processing the tubes at low temperature to prevent extreme expansion, using synthetic mica, or ceramics for spacers and redesigning the structure to obtain shorter electrodes and higher resonant frequencies for the elements.

Environmental Effects

High ambient temperatures, vibration and shock, and abnormal supply voltage contribute to unreliability. Operation in hot climates with the cabinet open promotes satisfactory results, while operation in air-conditioned vans gives normal life expectancy for certain tubes.

In the power supply of a radar bombing system, the power supply chassis was originally mounted in the nonpressurized part of the plane where there was inadequate ventilation. During flights above 30,000 ft, bulb temperature reached 315 C. The chassis was transferred to the pressurized zone of the plane and more effective blowers installed. A temperature check in the relocated chassis showed an average bulb temperature of 181 centigrade.

Misapplications

Severe misapplications are readily detected and corrected and do not constitute serious realiability problems. More troublesome are misapplications that produce only slight hardships. These include use of a tube at its maximum rating when there is available another type that could be operated at a more conservative rating; use of a type not actually designed for a particular application when a more suitable type is available; and use of several tubes in parallel to avoid the use of a larger tube.

Effects of Rare Earths On Low Carbon Steels

Abstracted from "Tricks that Make Shell Molding Click," by W. K. L. Bryce, International Harvester Co. of Canada Ltd.; based on secretary's report of Panel on Foundry Operations held as part of the SAE Toronto Production Forum, Oct. 29, 1953. Also abstracted in *SAE Journal*, April 1954.

RARE EARTH METALS have for some years been used as an inoculant in nonferrous foundry practice and lately in the production of nodular iron. It

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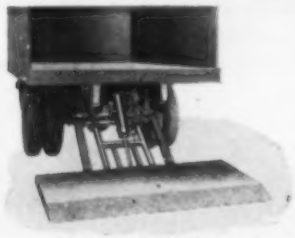

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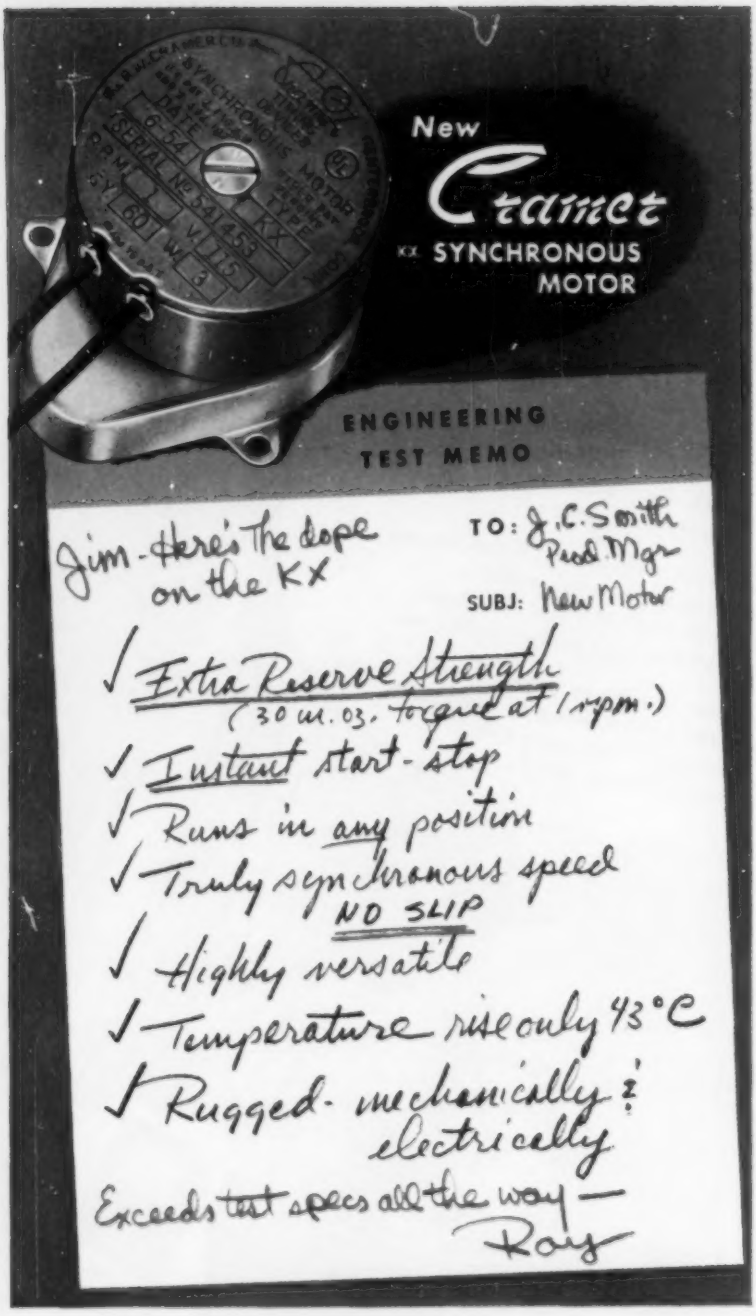

This does not tell the whole story by any means, but it does indicate the growing acceptance of this powerful motor for all types of instrument and control applications which require constant speed and dependability even under adverse environmental conditions. The complete story is yours for the asking. Write today.

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has been reported that addition of the metals to certain grades of stainless steel so improves high temperature malleability that reduction of larger size ingots in the blooming mill is now possible. It has also been reported that considerable improvements in soundness and mechanical properties of steel castings have been attained as a result of rare earth metals.

In an effort to extend these benefits to the production of medium carbon alloy and low carbon steels, a number of trials of the various rare earth addition agents have been made. These trials were to evaluate the effects of rare earths on mechanical properties of medium carbon alloy steels and on the surface quality of killed low carbon steel.

For purposes of evaluation a fine grain C1020 steel was chosen which, of the carbon steels, leaves much to be desired in regard to surface quality. Some alloy heats which were treated for other reasons were included only to show the effects of rare earth treatment on their sulfur content. With one or two exceptions no change in their normally good surface quality was observed. All heats treated were made by ordinary basic open hearth practice except that, in some cases, aluminum deoxidation was by additions to the molds. This was done to compare the effect of rare earth additions to silicon killed (coarse grain) and to aluminum killed (fine grain) steel from the same heat.

Of importance in any consideration of surface quality of killed low carbon steels is the amount of sulfur present and its relation to manganese content. It has been observed that as the manganese-sulfur ratio increases, the surface quality will, on the average, also improve. The rare earth metals form relatively stable sulfides in liquid steel which rise through the molten metal to form a slag, thereby eliminating sulfur. Iron and manganese also form sulfides but these are soluble in liquid steel so that no slag forms until solidification and no sulfur elimination is effected.

Although no consistent effect on surface quality as shown by the incidence of ingot cracks was observed after rare earth additions, several ingots did show evidence of hot shortness in association with additions of rare earth metals. This hot shortness appeared as corner tears along the

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edges of the blooms and, in more severe cases, the entire bloom surface was affected in this way. This condition can be evaluated by tensile tests pulled at high temperatures and by comparing the temperatures at which 80 percent reduction in area is obtained.

Summary

Additions of rare earth metals have been shown to reduce effectively the sulfur content of steel to which they are added either in the ladle or the mold. The efficiency of this removal depends on the amount of sulphur present and increases with increasing sulfur. Rare earth oxides showed very little effect on sulfur either as ladle or mold additions. Improvements in surface quality which did result from rare earth additions appeared to be due in large part to increase of low manganese-sulphur ratios. Where the manganese-sulfur ratio was high, no improvement resulted.

Addition of rare earth metals to aluminum killed steel in amounts greater than two pounds per ton resulted in a hot short condition more severe than that due to aluminum alone. This hot shortness resulted in hot tears during rolling which increased in severity with the amount of the rare earth metal additions. Rare earth oxides did not have this effect but instead reduced the effect of aluminum incorporated.

Tips on the Design Of Shell Molded Parts

Abstracted from "Rare Earth Additions Affect Surface Quality of Low Carbon Steel," as presented by J. V. Russell, Metallurgical Lab. Dir., Republic Steel Corp., Chicago, Ill., at the AIME National Open Hearth Steel Conference, Chicago, April 5 to 7, 1954. *Journal of Metals*, April 1954.

SHELL MOLDING has a lot to offer design engineers. With it, designers can get closer tolerances, finer finishes, and, in many cases, lower-cost end products—if they avoid the pitfalls!

Chief thing for designers to remember about tolerances is not to ask for the impossible. Cardinal rule here is to stick to tolerances that are feasible for a particular foundry. As a good yardstick for designers, today's shell-molding foundries are holding these tolerances: 0.003 to 0.005 in. per in.

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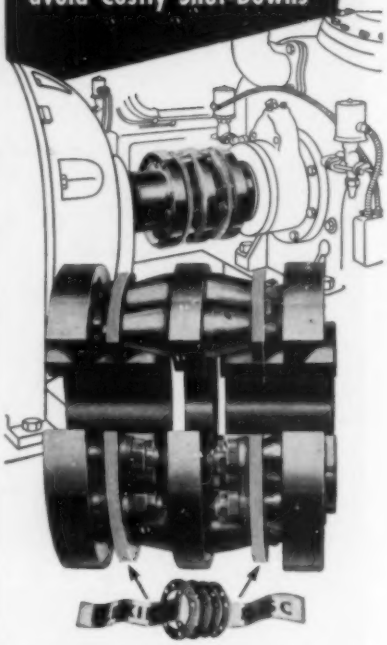

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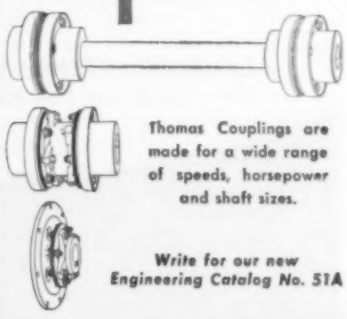

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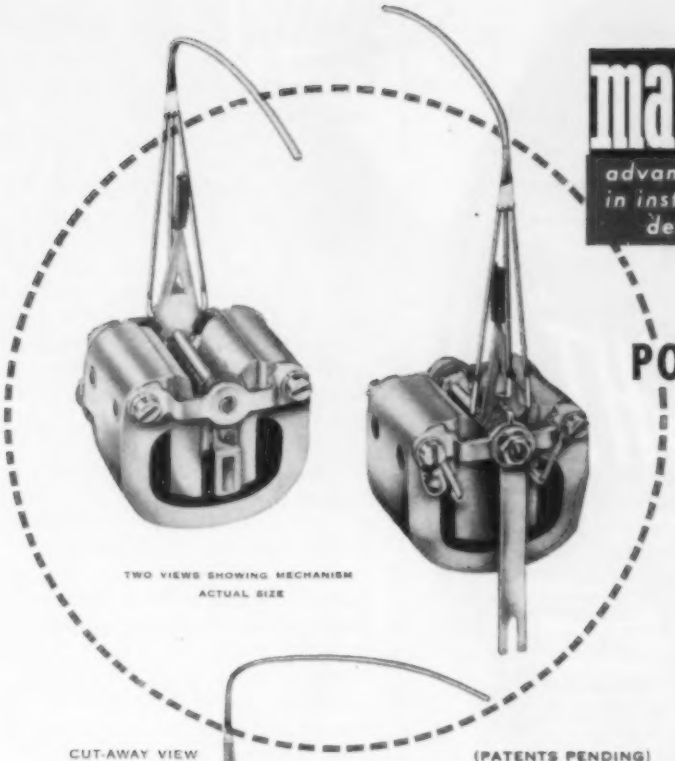

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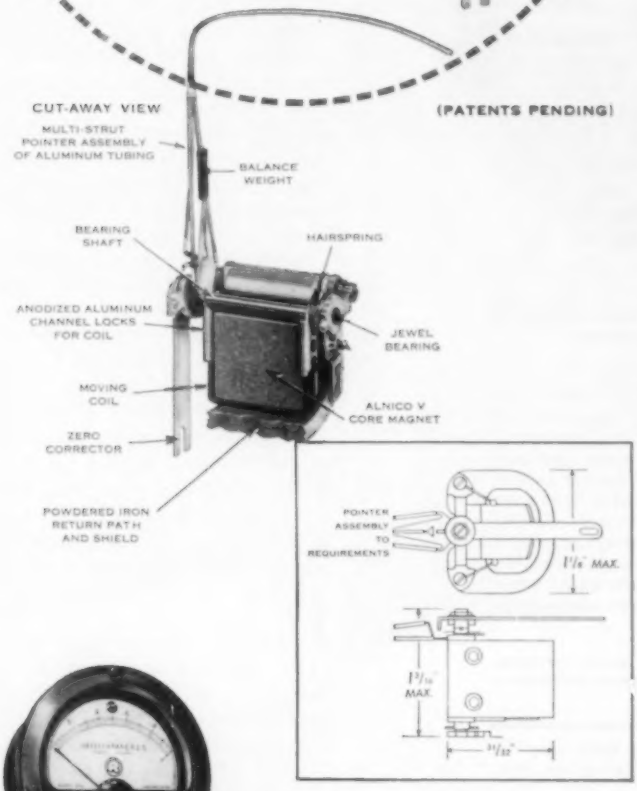

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marion meters

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PERKINS MAKES: helical gears, bevel gears, sprockets, ratchets, worm gears, spiral gears, spur gears with shaved or ground teeth, ground thread worms.

NOTE 1: A new product is the **Perkins Precision Spring Coiler.** This coiler (patent applied for) turns out precision springs — any type, shape, size, from wire sizes .005 to .125.

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PERKINS Machine & Gear Co.
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parallel to the parting line and 0.006 to 0.008 in., across the parting line. It has been found that control of tolerances is easier on smaller castings.

When it comes to actual design, it's important that parting over critical dimensions be avoided. Designs should be simple and laid out so that as much of the casting as possible can be made in the cope and drag. The less core work the better, since cores reduce the limits of dimensional accuracy.

Foundry costs, it is true, are usually higher with shell molding. But reduced or eliminated machining and finishing costs invariably more than make up for this. Shell molding, for that matter, does not pay off (especially on short runs) unless machining costs are drastically reduced. That's because the necessary patterns or thermo-dies cost two to three times as much as normal or green-sand patterns.

One pitfall wise designers will avoid is that of specifying too fine a finish. The finer the finish, the higher the cost of the casting. Reason for this is that the necessary finer sands require larger amounts of resin to coat the increased surface area. And while the resin in a shell mold comprises only about 6 percent of the total weight, it represents approximately 80 percent of the total cost of the sand-resin mix.

As for the all-important question of what parts should and should not be shell molded, a good rule of thumb is: If the weight of the metal in the casting is twice that of the sand and resin used to make the mold, then shell molding is competitive with green-sand molding. However, mechanization of the shell-molding process is helping to make it more competitive.

Having made the decision to use shell molding, the designer should bear in mind the following things (1) with the shell-molding process, the die must be heated to 450 to 500 F. Gas heating is preferred, since electricity does not give uniform face temperature on the pattern. (2) Gating must be correct the first time. This is because thermo-dies cannot be soldered or altered in the conventional manner. (3) Die surfaces must be very smooth and accurate. (4) Shells must be ejected evenly and in one plane, otherwise they will become warped while hot. (5) Shell molding seems to offer better strength and lower hardness in castings with sections up to $\frac{3}{16}$ in. thick.

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In "Custom-Built" and "Stock" Models

HARD CHROME PLATED PISTON RODS
Prevent Scratch-Damage, Nicks and Rust

DIRT WIPER SEALS
Protect Rods, Seals, Bushings

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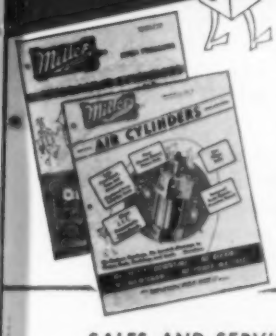
NON-CUSHIONED: 2", 2½", 4", and 6" bore sizes, each available in 2," 4", 6", 8", and 11" stroke lengths.

CUSHIONED BOTH ENDS: 2", 3¼", 5" and 8" bore sizes, each available in 3", 5", 7", 9", and 13" stroke lengths.

"Stock" Cylinders are base Model A53 with foot, flange, and pivot mounting attachments available as desired.

NOTE: "Stock" Miller Hydraulic Cylinders also available!

Write for Complete "Stock" List



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Complete Miller cylinder line includes: air cylinders, 1½" to 20" bores, 200 PSI operation; low pressure hydraulic cylinders, 1½" to 6" bores for 500 PSI operation, 8" to 14" bores for 250 PSI; high pressure hydraulic cylinders, 1½" to 12" bores, 2000-3000 PSI operation. All mounting styles available.

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Only .94 cubic inches in size... only 1.2 ounces in weight—yet this new ADVANCE TQ telephone type carries 3-amp. loads in the 4PDT combination. It's available up to 6PDT, and with class "H" insulation such as Teflon, ceramic and silicone.

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Insulation is inorganic, and the coil requires no impregnation or filler. Hence there is no gassing or bubbling to cause contact contamination. The TQ relay is mechanically secured throughout—a feature that adds materially to its high efficiency.

EXCELLENT PERFORMANCE

The unit operates on 90 milliwatts or less, and hence can be classed as a sensitive type. Withstands 10G vibration (10 to 55 CPS). Ambient temperature ranges: −55°C to +85°C with standard coil... with Teflon coil, −55°C to +125°C. Life expectancy: 1,000,000 cycles with cross-bar contacts. Available in open and hermetically sealed types. Write for full description of the ADVANCE TQ.

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NEW BOOKS

Symposium on Porcelain Enamels And Ceramic Coatings As Engineering Materials

Presented at the 56th Annual Meeting of the American Society for Testing Materials. 6 x 9 *in.*, 128 *pp. Headquarters of the ASTM,* 1916 *Race St., Philadelphia* 3, *Pa.,* $2.50.

This symposium was set-up as a carefully planned and thorough effort to acquaint the engineering profession with growing ceramics technology. In the program itself, due attention was given to a number of important but diversified fields to which such coatings are particularly adapted, covering areas where an attractive, easily maintained surface is desired or where metal is subjected to deterioration by heat, abrasion, vibration or chemical contact. Subjects covered include: Weathering Resistance of Porcelain Enamels; Chemical Resistance of Glass Fused to Steel; Acid Resisting Properties of Porcelain Enamel; Application of Coatings to High Temperature Components of a Jet Engine; Industrial Processing of High-temperature Ceramic Coatings; Abrasion Resistance of Various Types of Porcelain Enamel; Resistance of Porcelain Enamel to Surface Abrasion; Torsion Testing of Porcelain Enamel; and Effect of Temperature on Electrical Resistivity of Silicone and Ceramic Type Coatings.

Characteristics and Applications Of Resistance Strain Gages

Proceedings of symposium held November 8 *and* 9, 1951, *National Bureau of Standards Circular* 528. 6 x 9 *in.*, 140 *pp. Published by National Bureau of Standards, Office of Scientific Publications, Washington* 25, *D. C.,* $1.50.

The papers presented at this symposium represent some of the latest results, both experimental and theoretical, in the study of resistance strain gages by leading institutions in the United States and abroad.

Though resistance strain gages are a comparatively new tool in the study of materials and structures, they have con-

when arc resistance is important . . . and moisture-absorption isn't

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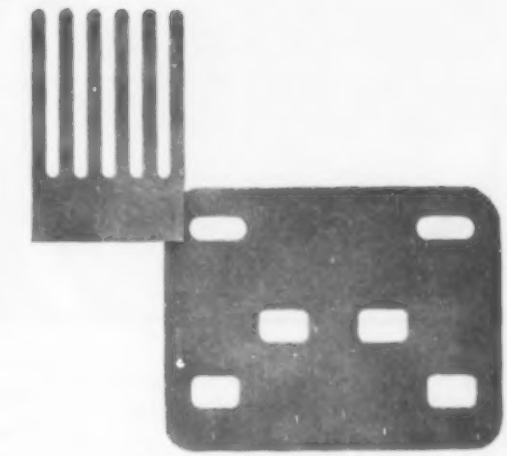

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If moisture pick-up is not critical, DUROID 800 is just as effective an insulating material as higher-priced XP paper-base laminates (which we also make). DUROID 800's arc resistance is better and its tensile and impact strengths are higher. Dielectric strength is excellent when dry. It punches cleanly, takes riveting and can be made flame retardant.

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sistently found wider use. Strain gages have been used in measurement of mechanical quantities such as acceleration, impact force and dynamic pressure. They have been applied as the sensing element in a multitude of instruments, and have been used to determine strain distribution in structures, from airplane wings to bridges.

Papers presented at the symposium covered these applications and also reported new work in progress on strain gages consisting of a conductive coating applied by an evaporation technique, on special temperature compensated gages, on gages for strain measurement well beyond the elastic range, and on the application of strain gages to the determination of dynamic properties of materials and to the measurement of very large static forces. Eleven papers are reported in the volume along with transcriptions of the discussions that followed, including: Poisson-ratio Determinations for Elastic and Plastic Strains of Tensile Specimens; Cementing and Waterproofing of Resistance Strain Gages; Unbonded Resistance-Wire Strain Gage; An Imbedded Bonded-Wire Strain Gage for Measuring Internal Strain in Concrete; Properties of Concrete under Impact as Measured with Bonded-Wire Strain Gages; A New Strain Gage without Transverse Sensitivity; How to Use G-H Gages; Bonded-Wire Strain Gage in the Field of Instrumentation; Commercial Weighing with Resistance Strain Gages; Application of Resistance-Wire Strain Gages to High-capacity Load-calibrating Devices; and Preliminary Investigation of the Strain Sensitivity of Conducting Films.

Copper

Edited by ALLISON BUTTS, *Hd., Dept. of Metallurgical Engrg., Lehigh University. 6 x 9 in., 936 pp. Published by Reinhold Publishing Corp., 330 West 42 St., New York 36, N. Y., $20.*

This volume, a new unit in the American Chemical Society's Monograph Series, is designed to answer the need for a fully comprehensive book on copper. As a reference work on all important phases of the subject, both as a chemical element and as an industrial metal, the book treats the whole subject through a planned sequence of original articles, not through

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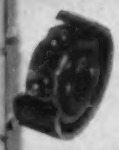
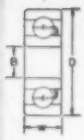
RADIAL TYPES

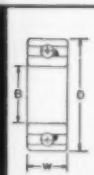


Retainer



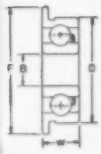
Brg. No.	B	D	W
R0	3/64 (.0469)	5/32 (.1562)	1/16 (.0625)
R1	(.0550)	3/16 (.1875)	5/64 (.0781)
R1-4	5/64 (.0781)	1/4 (.2500)	3/32 (.0937)
R1-5	3/32 (.0937)	5/16 (.3125)	7/64 (.1094)
R2-5	1/8 (.1250)	5/16 (.3125)	7/64 (.1094)
R2	1/8 (.1250)	3/8 (.3750)	5/32 (.1562)

Retainer Extra Light



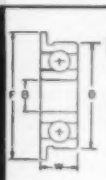
R133	3/32 (.0937)	3/16 (.1875)	1/16 (.0625)
R144	1/8 (.1250)	1/4 (.2500)	3/32 (.0937)
R155	5/32 (.1562)	5/16 (.3125)	7/64 (.1094)
R156	3/16 (.1875)	5/16 (.3125)	7/64 (.1094)
R166	3/16 (.1875)	3/8 (.3750)	1/8 (.1250)
R168	1/4 (.2500)	3/8 (.3750)	1/8 (.1250)
R188	1/4 (.2500)	1/2 (.5000)	1/8 (.1250)
R613M	6mm.	13mm.	3.5mm.

Flanged Retainer



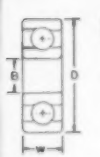
FR1	(.0550)	3/16 (.1875)	5/64 (.0781)
FR1-4	5/64 (.0781)	1/4 (.2500)	3/32 (.0937)
FR1-5	3/32 (.0937)	5/16 (.3125)	7/64 (.1094)
FR2-5	1/8 (.1250)	5/16 (.3125)	7/64 (.1094)
FR144	1/8 (.1250)	1/4 (.2500)	3/32 (.0937)
FR155	5/32 (.1562)	5/16 (.3125)	7/64 (.1094)
FR156	3/16 (.1875)	5/16 (.3125)	7/64 (.1094)
FR166	3/16 (.1875)	3/8 (.3750)	1/8 (.1250)
FR188	1/4 (.2500)	1/2 (.5000)	1/8 (.1250)

Flanged Full



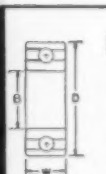
F13	(.0550)	3/16 (.1875)	5/64 (.0781)
F14	5/64 (.0781)	1/4 (.2500)	3/32 (.0937)
F15	3/32 (.0937)	5/16 (.3125)	7/64 (.1094)
F154	1/8 (.1250)	5/16 (.3125)	7/64 (.1094)
F155	5/32 (.1562)	5/16 (.3125)	7/64 (.1094)
F156	3/16 (.1875)	5/16 (.3125)	7/64 (.1094)

Full



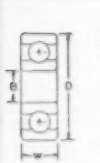
10	(.0250)	(.1000)	1/32 (.0312)
12	(.0400)	1/8 (.1250)	3/64 (.0469)
12½	3/64 (.0469)	5/32 (.1562)	1/16 (.0625)
13	(.0550)	3/16 (.1875)	5/64 (.0781)
14	5/64 (.0781)	1/4 (.2500)	3/32 (.0937)
15	3/32 (.0937)	5/16 (.3125)	7/64 (.1094)
16	1/8 (.1250)	3/8 (.3750)	5/32 (.1562)

Full Extra Light



144	1/8 (.1250)	1/4 (.2500)	3/32 (.0937)
154	1/8 (.1250)	5/16 (.3125)	7/64 (.1094)
155	5/32 (.1562)	5/16 (.3125)	7/64 (.1094)
156	3/16 (.1875)	5/16 (.3125)	7/64 (.1094)
157	7/32 (.2187)	5/16 (.3125)	7/64 (.1094)
168	1/4 (.2500)	3/8 (.3750)	1/8 (.1250)
1810	5/16 (.3125)	1/2 (.5000)	5/32 (.1563)

Spring Separator



R1-4Z	5/64 (.0781)	1/4 (.2500)	3/32 (.0937)
R1-5Z	3/32 (.0937)	5/16 (.3125)	7/64 (.1094)
R2-5Z	1/8 (.1250)	5/16 (.3125)	7/64 (.1094)
R2Z	1/8 (.1250)	3/8 (.3750)	5/32 (.1562)
R168Z	1/4 (.2500)	3/8 (.3750)	1/8 (.1250)

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► TOLERANCES are ABEC5 or BETTER.

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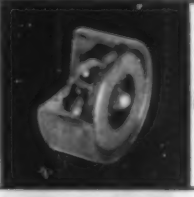
Brg. No.	B	D	W
FR1-P,PP	(.0550)	3/16 (.1875)	(.1094)
FR1-4P,PP	5/64 (.0781)	1/4 (.2500)	(.1406)
FR1-5P,PP	3/32 (.0937)	5/16 (.3125)	(.1406)
FR2-5P,PP	1/8 (.1250)	5/16 (.3125)	(.1406)
FR2-P,PP	1/8 (.1250)	3/8 (.3750)	(.1562)
FR144P,PP	1/8 (.1250)	1/4 (.2500)	(.1094)
FR155P,PP	5/32 (.1562)	5/16 (.3125)	(.1250)
FR156P,PP	3/16 (.1875)	5/16 (.3125)	(.1250)
FR166P,PP	3/16 (.1875)	3/8 (.3750)	(.1562)
FR168P,PP	1/4 (.2500)	3/8 (.3750)	(.1250)
FR188P,PP	1/4 (.2500)	1/2 (.5000)	(.1875)

Shielded Radial

R0P,PP	3/64 (.0469)	5/32 (.1562)	(.0937)
R1P,PP	(.0550)	3/16 (.1875)	(.1094)
R1-4P,PP	5/64 (.0781)	1/4 (.2500)	(.1406)
R1-5P,PP	3/32 (.0937)	5/16 (.3125)	(.1406)
R2-5P,PP	1/8 (.1250)	5/16 (.3125)	(.1406)
R2P,PP	1/8 (.1250)	3/8 (.3750)	(.1562)
R144P,PP	1/8 (.1250)	1/4 (.2500)	(.1094)
R155P,PP	5/32 (.1562)	5/16 (.3125)	(.1250)
R156P,PP	3/16 (.1875)	5/16 (.3125)	(.1250)
R166P,PP	3/16 (.1875)	3/8 (.3750)	(.1562)
R168P,PP	1/4 (.2500)	3/8 (.3750)	(.1250)
R188P,PP	1/4 (.2500)	1/2 (.5000)	(.1875)

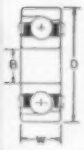
OTHER TYPES



Pivot

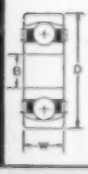
Brg. No.	B	D	W
22½M	(.040)	4mm.	2.4mm.
23M	(.050)	5mm.	3.2mm.
24	(.085)	1/4 (.2500)	1/8 (.1250)
24H	(.085)	1/4 (.2500)	1/8 (.1250)
26	(.165)	3/8 (.3750)	3/16 (.1875)
26H	(.165)	3/8 (.3750)	3/16 (.1875)

Angular Contact



113	(.0550)	3/16 (.1875)	5/64 (.0781)
114	5/64 (.0781)	1/4 (.2500)	3/32 (.0937)
115	3/32 (.0937)	5/16 (.3125)	7/64 (.1094)
1154	1/8 (.1250)	5/16 (.3125)	7/64 (.1094)
116	1/8 (.1250)	3/8 (.3750)	5/32 (.1562)

Self Aligning



214	5/64 (.0781)	1/4 (.2500)	3/32 (.0937)
215	3/32 (.0937)	5/16 (.3125)	7/64 (.1094)
2154	1/8 (.1250)	5/16 (.3125)	7/64 (.1094)
216	1/8 (.1250)	3/8 (.3750)	5/32 (.1562)

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With the introduction of an exclusive new oil-eliminating feature, Nicholson air traps now enable you to enjoy the advantages of the positive intermittent action of a float-operated air trap without the common problem of oil congealing on the mechanism and impeding or stopping its action. Other features of Nicholson air traps:

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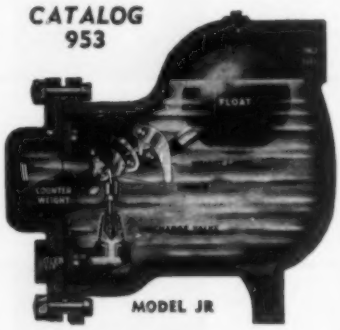
CATALOG 953



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a review of the literature on copper. Almost 39 percent of the space in the monograph is devoted to the field of occurence and extractive metallurgy of copper, 16 percent to the physical and mechanical metallurgy of copper and its alloys, 18 percent to properties and applications, and 27 percent to various aspects of copper chemistry and physics not included in the more general divisions.

Among the topics covered are: Copper Minerals and Ore Deposits; Smelting, Converting and Refining; Melting and Casting; Hydrometallurgy; Physical and Chemical Properties; Corrosion Resistance; Brass, Bronze and other Copper Alloys; Hot and Cold Working; The Physical and Analytical Chemistry of Copper; Phase Diagrams of Binary and Ternary Copper Alloys; Details of Applications in Various Industries; Copper Compounds; and Uses of the Element in Organic Chemistry, Biology and Agronomy. Extensive bibliographies are appended to most chapters.

Lubrication of Industrial And Marine Machinery

Based on a work by the late WILLIAM GORDON FORBES. *Second Edition. Revised by* C. L. POPE, *Lubrication Engr., Eastman Kodak Co., and* W. T. EVERITT, *Lubrication Engr., Eastman Kodak Co.* 6 x 9 *in.*, 351 *pp. Published by John Wiley & Sons, Inc.*, 440 *Fourth Ave., New York* 16, *N. Y.*, $6.50.

The purpose of this book is to provide a manual that may be used to explain the fundamental characteristics of conventional lubricants. It follows the scope and purpose of the original, but incorporates the addition of new material and revision of some practices stemming from developments during the past nine years. Some of the more common basic mechanisms, such as bearings, gears, pumps, compressors, have been explained in some detail. The integration of the lubrication principles with the lubrication requirements of mechanisms, as explained in this book, is intended to permit the solving of lubrication problems.

The topics are arranged in sequence, and basic principles are evolved in a manner calculated to avoid needless repetition. The first fourteen chapters deal with chemistry, refining, com-

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pounding, and specifications for lubricants. Also covered are limitations to which certain types of lubricants can be extended. The second part, Chapters fifteen through thirty-two, explain the lubrication requirements of the most common types of machinery. The concluding chapters give practical examples of how the knowledge gained may be applied to the lubrication of equipment.

Typical chapter headings are: Distillation of Lubricating Oils; Solid Lubricants; Additives for Lubricants; Greases; Synthetic Lubricants; Bearing Lubrication and the Formation of Oil Films; Ball and Roller Bearings; Hydraulic Systems and Fluid Couplings; Reduction Gears; Heat Treating Oils; and Lubrication Engineering.

Fundamentals of the Working of Metals

G. SACHS, *Institute of Industrial Research, Syracuse University.* 5½ x 8½ *in.*, 158 *pp. Published by Interscience Publishers, Inc., 250 Fifth Ave., New York* 1, *N. Y.*, $4.75.

The chapters of this book present an elementary description of the basic phenomena which determine the performance of metallic materials on mechanical working. They apply equally to the two large commercial fields where working, forming or plastic deformations are used to arrive at the desired shape of a metallic product, its *processing* into simple shapes, such as plate, sheet, strip, billets, bar, rod, wire, tube, and the *fabricating* of these into more complex, finished parts and articles.

The performance of a metal or alloy during forming is extremely complex and depends upon a large number of chemical, metallurgical, and mechanical factors. As many commercial forming processes are highly advanced, they require materials, equipment, and operations that are as nearly perfect as is humanly possible. As a consequence, the closest tuning of or cooperating between these elements in the metalworking plant is necessary. Small variations in these elements or small deviations from established conditions frequently result in great losses in material, machine parts and time.

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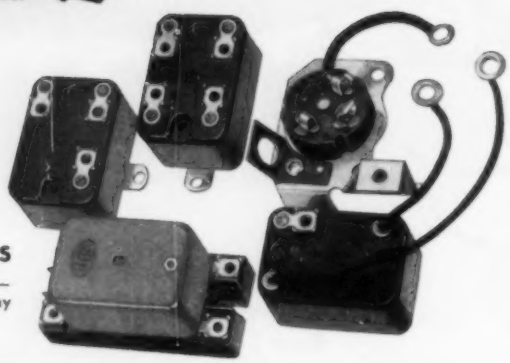

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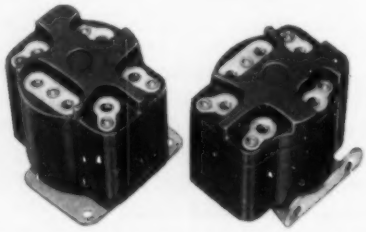

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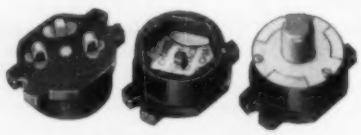

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or "know-how" an organization and its key-personnel possess, the more successful they are in this respect. However, modern development of science and technology offer an alternative for this method, namely a thorough knowledge of the basic facts which determine the properties of materials, the functioning of equipment and the interweaving of operations.

In the various chapters of this book an attempt is made to present an elementary and simple discussion of such basic facts which determine the success or failure of a forming operation. Super-simplicity in this respect cannot be expected as it would result in considerable omissions and distortions of facts which depend upon complex inter-relations between several phenomena.

Elements of Electrical Machine Design

ALFRED STILL, *Prof. Emeritus of Electrical Engrg., Purdue University, and* CHARLES S. SISKIND, *Asst. Prof. of Electrical Engrg., Purdue University. 6 x 9 in., 445 pp. Published by the McGraw-Hill Book Co., Inc., 330 West 42 St., New York 36, N. Y. $9.*

This third edition is primarily concerned with the principles and practices of electrical machine design. The material has been rearranged to unify the broad, basic subject matter and to emphasize the interrelation of the physical and operating characteristics of the various parts of a complete machine.

As in previous editions, the text is directed toward all students of electrical engineering to aid them in understanding fundamental principles through their application to concrete designs of electrical machines. The design constants have been modified to conform with present day practices, taking account of improved methods and materials. The book has also been brought into better accord with the type of power machine course currently given in colleges and universities.

The design principles of four basic types of machine are covered in detail: d-c generators, a-c generators, induction motors and transformers. Deviations of equations are rigid and based on fundamental principles. When derived formulas are modified to take

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tests, it is indicated that the use of empirical constants makes it possible to relate electric and magnetic quantities to physical dimensions.

Specifically, the chapters are headed as follows: (1) Introduction, (2) Dynamic Electric Machinery—General Design Principles, (3) Armature Windings and Armature Design Principles, (4) Commutation and Design of Commuting Poles, (5) Tooth Reluctance and Armature Reactance—Design of Field Magnets and Windings, (6) Losses, Ventilation and Temperature Rise, (7) Alternating Current Machinery—Synchronous Generators, (8) Synchronous Generators (cont'd), (9) Synchronous Generators (concluded), (10) Polyphase Induction Motors—Design of Three-Phase Motor, (11) Polyphase Induction Motors (Cont'd), (12) Alternating Current Transformers, and (13) Mechanical Design of Electrical Machinery.

Non-Ferrous Foundry Metallurgy

Edited by A. J. MURPHY, *M.Sc., F.I.M., Professor of Industrial Metallurgy, University of Birmingham.* 6 x 9 *in.*, 497 *pp. Published by McGraw-Hill Book Co.*, 330 *West* 42 *St., New York* 36, *N. Y.*, $12.50.

The metallurgical industry is becoming more and more dependent upon technical control. The devising of systems of control and the responsibility for their successful operation calls for trained metallurgists in ever increasing numbers. These men must know the scientific bases upon which fundamentally sound practice can be founded. Here are enunciated these basic principles.

In this book, published in cooperation with the Pergamon Press in England, the metallurgy of the alloys and the processes in non-ferrous foundry work is dealt with in a manner which recognizes that progress in this branch of technology has ceased to depend upon the development of operative skills. Instead it must be based upon the understanding and application of scientific principles.

The text covers the general principles unifying the foundry techniques of all the industrial non-ferrous metals in relation to metals in the liquid

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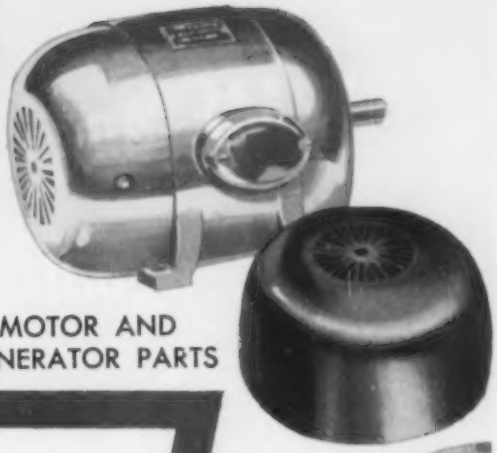

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state, to the process of solidification and to the facts influencing the properties of casting. Other new materials include the part played by gas dissolved in liquid metals, its control and its influence on cast products; factors influencing the grain size of castings; mechanical properties of castings as complete components compared with the properties in conventional test samples.

Chapter titles are: Introduction; Some Properties of Liquid Metals; The Solution of Gases in Liquid Metals; Solidification; Solidification (cont'd); Non-Ferrous Foundry Technology; Properties and Testing of Castings; Properties and Testing of Castings (cont'd); Casting Alloys; and Casting Alloys (cont'd).

Machinery's Handbook

Fifteenth Edition, 1, 911 *pp*, 4½ x 7 *in. Published by The Industrial Press, 148 Lafayette St., New York* 13, N. Y., $9.

This new edition makes possible the recent and basic information, data and formulas that the handbook user in the mechanical field needs to keep abreast of current developments.

Of particular interest in the fifteenth edition are a revised and rearranged spur gear section and an entirely new section on generated bevel gears. Featured in the spur gear section is a greatly enlarged presentation of standard definitions and terms; formulas and tabulated data for readily determining the dedendums and root diameters for hobbing and shaping preshaved gears; full data and information on fine-pitch spur gears, including tolerances for gear blanks, and data for enlarged pinions; and recommendations and tabulated data for obtaining the proper amount of backlash in various types of gears.

In the bevel gear section, the various types of bevel gears and their applications are described. A detailed presentation of the revised Gleason system of straight and bevel gears is included with formulas, charts and step-by-step procedures for designing bevel gears for durability and strength. In addition, there are formulas and methods for determining thrust and radial loads, and a table of recommended bevel gear materials.

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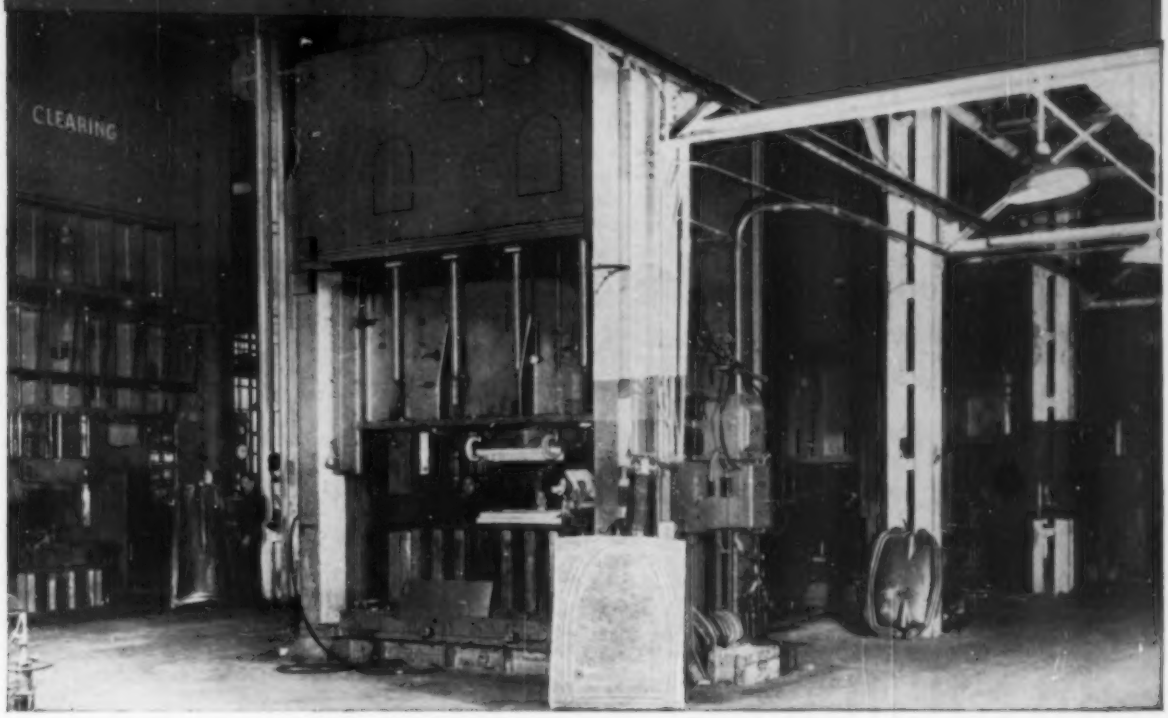

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and worm gears has been added in which the step-by-step design procedure is outlined and formulas are given for obtaining profile and pressure angle corrections for cutters and grinding wheels used to produce fine-pitch worms.

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Thread classes, thread form, allowances, tolerances, limiting dimensions, and preferred thread series of the American Standard General-purpose Acme and Stub Acme screw threads are given in the extensive and detailed screw thread section.

The section on ball, roller and needle bearings is completely new and gives in considerable detail and scope the descriptions, designations and tolerances for standard anti-friction bearings. Also outlined is the Anti-Friction Bearing Manufacturers Association plan for bearing designation. Standard minimum shaft shoulder and maximum housing shoulder dimensions for ball and cylindrical roller bearings are also given.

The new milling cutter section now gives extensive tables of dimensions and tolerances covering the various types of American Standard milling cutters, together with a table showing four types of set-ups for grinding clearance angles on milling cutter teeth.

Standard dimensions of tool shanks, toolpost openings, lathe center heights, types of standard toolposts, lengths of solid square and rectangular tolls, and dimensions and commercial catalog numbers of sintered-carbide tips for single-point tools are now an important part of the small cutting tools section.

Additions to the section on honing include formulas and data for determining the proper rotative speeds, recommended tolerances, allowances for stock removal, and possible adjustments for eliminating undesirable conditions. In the materials section, new data on nickel and nickel alloys, titanium and titanium alloys, and copper-silicon and beryllium alloys are presented.

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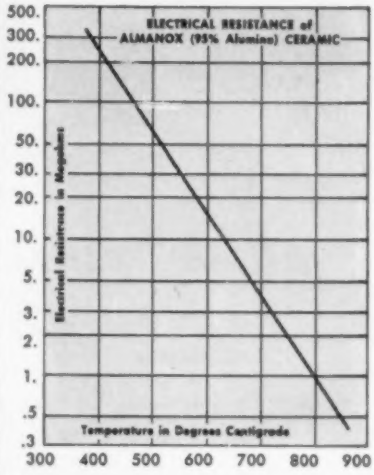

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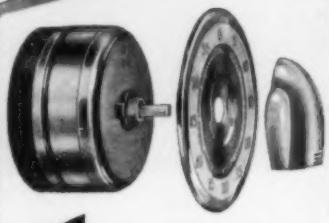

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Acknowledgment Due

To the Editor:

I was more than a little surprised to find that an article in the 1954 *Handbook of Product Design* had several direct quotations from our 1953 catalog.

This, of course, is very flattering, although I would have been somewhat happier if we had been accorded a credit line.—H. D. GILBERT, *President*
Miniature Precision Bearings, Inc.

Ed—Mr. Gilbert is correct in that we did quote from his catalog, as he states. Our apologies for failing to acknowledge the source.

Interdependence Requires Accepted Standardization In Drafting Practice

To the Editor:

Your March editorial, headed "We Are Not Independent," exactly expresses my opinion concerning *Simplified Drafting*. Independent departures, stemming from both industrial and educational sources, tend to befuddle standardization, which was nearer to common usage 30 years ago than is today's conglomeration.

We have gone away from a standard and we no more need a new method than we need a new dictionary. To get back to a standard all we have to do is to practice that which we have, such as ASA, and augment it with a "Do" and "Do Not" standard practice manual which every draftsman and every plant can use and appreciate why they should stay within it.

The feature of such a manual is the timesaving it will accomplish because such a large percentage of the contents of drawings as we now make them is: (1) repetition, (2) unnecessary, (3) stilted and vague, and (4) we have too many notes and not

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ALUMINUM REPORTER

MODERN DESIGN HAS ALUMINUM IN MIND

★ ★ ★ Fourteenth in a Series to Industry on Aluminum Uses and Developments ★ ★ ★

NEW ALL-ALUMINUM MOBILE HOME MAKES NEWS

Aluminum and Plastic Team Up to Make New, Improved Wading Pool

This novel wading pool made by the Ideal Toy Corporation, New York 10, N.Y., offers a good example of design and engineering skill in getting maximum benefit from the right combination of materials in a product. Ideal engineers wanted a sturdy pool—yet one easily inflatable and simple to set up. They found the solution through judicious use of both aluminum and plastic.

Named the "Aquarama," this wading pool features an all-aluminum wall with safety rolled edges and an inflatable one-ring inner liner made of heavy gauge vinyl. The aluminum wall—made of Reynolds Aluminum—prevents loss of water experienced with unsupported depressed sides and also protects the plastic against rough use. This non-rusting aluminum wall rolls into a compact coil around the deflated pool and comes packed in a convenient shipping carton. Pool with Inflato-Pump and other extras retails for under $20.

This Ideal Wading Pool is sold in sporting goods, furniture, hardware and other stores handling children's play equipment. It also is one of the growing number of quality products that carry the new "Designed in Reynolds Aluminum" Seal. For details on how the aluminum products you fabricate can qualify for this seal merchandising program simply write to the address below.

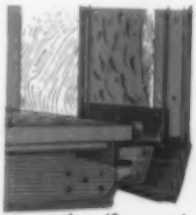
Reynolds design and engineering service is available to all manufacturers, not only those working exclusively with aluminum but also to those who use it in combination with other materials in their products. To get the most from the aluminum you use—alone or judiciously combined with other materials—call your nearby Reynolds Office, Reynolds Distributor, or write Reynolds Metals Company, 2576 So. Third St., Louisville 1, Ky.

Mon-O-Coach "041" Hailed as Major Design and Engineering Achievement in Mobile Home Development

The revolutionary all-aluminum Mon-O-Coach "041" Mobile Home shown above features new monocoque stratoliner construction in which the entire body of Reynolds Aluminum is one strong unit instead of body-on-frame construction. The drawing below shows how extruded aluminum bottom, sidewall and top members make a one-piece riveted unit reinforced with aluminum castings.

Reynolds engineers were asked in by the builder—the Mon-O-Coach Division of Ironwood Trailer Coaches, Inc., Ironwood, Michigan—right at the initial design stage. These Reynolds engineers worked closely with Mon-O-Coach engineers through completion of the job.

According to the manufacturer, Reynolds Aluminum and monocoque construction make this mobile home up to 4,000 pounds lighter—structurally about one-third lighter than conventional trailers—more mobile . . . easier to pull . . . more economical on the road. All-aluminum construction also eliminates any chance of buckling, warping, corrosion and bi-metallic action.



The assistance of Reynolds engineering and styling service is available without obligation to help manufacturers make full use of aluminum's many advantages. For example, aluminum is light but strong . . . is always attractive (frequently without special finishes) . . . has excellent heat and light reflectivity . . . high electrical and thermal conductivity . . . is low in cost and often permits fabrication economies.

Consult Reynolds Aluminum specialists on your next design or redesign project. Call the Reynolds Office or your nearby Reynolds Distributor listed under "Aluminum," in your classified telephone directory, or write direct.

New Reynolds Rotor Metal Used in Induction Motors

Reynolds development work has proved that a new rotor metal of 99.3% minimum aluminum content with a conductivity of 54 to 57% of the annealed copper standard will produce motors averaging as high or higher torque than higher purity, higher conductivity range material.

This apparent contradiction is the result of close control of the alloying elements. When cast in this metal the rotor bars are less apt to pull apart during solidification and cause loss of electrical contact and ultimate loss of torque. Also, the aluminum has less tendency to weld to the laminations and welding that does occur is broken free more easily by subsequent heating.

Prime advantages of die cast aluminum rotors over copper windings for induction motors are lower material and fabricating costs and lower centrifugal forces exerted on bearings during the motor operation. Write for more complete information.

For more complete aluminum design information send for "Aluminum Structural Design" and "Designing with Aluminum Extrusions." Single copies of these handbooks are free when requested on business letterhead. Write Reynolds Metals Company, 2576 South Third Street, Louisville 1, Kentucky.

MORE INTERESTING NEWS ABOUT ALUMINUM ON NEXT PAGE

(Advertisement)

Printed in U.S.A.

(Continued From Preceding Page)

New Automatic Welder Used to Lay Longest Aluminum Pipeline

A new portable automatic welding machine, used during the laying of the longest aluminum pipeline ever installed, welded 40-foot sections of 8⅝-inch aluminum pipe in an average time of four minutes for a five pass weld, compared to about eight minutes or more for welding pipe in place by hand, the method commonly used for steel pipe.

Suspended over the line by a side boom, the automatic welder is equipped with quick-acting clamps which grip the pipe. Pressing a button starts the welding and automatic controls maintain proper conditions of the arc. When the weld is complete, the machine automatically stops, reverses itself, and returns to the starting position. The clamps are released and the machine moves to the next weld.

Welds made during the laying of a 12-mile high-pressure line were subjected to pressure as high as 1800 pounds per square inch, and held firmly. The 40-foot aluminum pipe sections used weigh only 320 pounds while the same size section of steel pipe weighs about 1000 pounds. Reynolds technicians point out that this makes possible savings in handling, equipment and labor which virtually offset the higher cost of aluminum pipe.

The new machine—used in laying the high-pressure pipeline between the White Point gas field near Corpus Christi, Texas and the Reynolds Metals Company LaQuinta alumina plant—was a cooperative development of Reynolds and Air Reduction Sales Company.

Reynolds and Unions Observe "Twenty Years of Harmony"

Production workers in Reynolds Metals Company's Louisville, Kentucky plants recently expressed their appreciation for 20 years of harmonious labor-management relations by presenting a scroll to R. S. Reynolds, Sr., chairman of the Reynolds Metals board of directors and founder of the aluminum firm.

Matt. W. Davis, business agent for Aluminum Workers Local 19388, serving as spokesman for that local and 12 other unions with a total of 2300 workers in the Reynolds Louisville plants, declared: "Our local doesn't have one unanswered grievance. The company very readily sits down and works out any problem it has with a union. It has been about seven years since we had to take a case to arbitration. And we have full employment."

Many Diversified Industries Take Advantage of the Vast Production Facilities Offered by Reynolds Aluminum Fabricating Service

More companies in more industries are taking advantage these days of the facilities offered by Reynolds Aluminum Fabricating Service for producing aluminum parts. Following are some of the reasons why so many companies in both large and small industries are using this service.

New Technical Handbook, "Heat Treating Aluminum Alloys," Now Available From Reynolds

This new 122 page handbook—containing more than 75 photographs, drawings and tables—explains the principles and procedure for heat treating the aluminum alloys.

The book is in three parts. One section presents in easily understood form the metallurgy involved in the heat treatment of aluminum alloys. Another section is of particular interest to the metallurgist and contains data of a more technical nature on both heat-treatable and non-heat-treatable aluminum alloys. A third section presents complete technical processing data in easy-to-follow tabular form.

Single copies of "Heat Treating Aluminum Alloys," are free when requested on your business letterhead (otherwise the book is $1.00). A complete index of Reynolds design, fabrication and application literature is also available. Write to Reynolds Metals Company, 2576 South Third Street, Louisville 1, Kentucky.

Aluminum Irrigation Pipe Helps Fight Ground and Forest Fires in Michigan

Aluminum irrigation pipe has been used successfully for water transmission to ground fires by the Department of Conservation in the State of Michigan. They started with 1600 feet of 3-inch aluminum pipe and quick acting aluminum couplers supplied by the W. R. Ames Company, irrigation equipment manufacturers, of San Francisco. When this proved highly successful, additional footage was ordered.

In one ground fire where both aluminum pipe and hose were used, the 1600 feet of 3-inch pipe was loaded on a trailer by four men in just thirty minutes while it took five men two hours and twenty minutes to load 2000 feet of 2½" hose. In addition, four men were kept busy for an entire eight hour day to uncouple, dry, clean and roll the hose—another case where aluminum irrigation pipe saved time and labor.

First, there are over 200 pieces of major production equipment in two plants alone operated by Reynolds Aluminum Fabricating Service. This equipment includes presses from the very smallest up to presses capable of producing drawn parts 12′ long. Also included are roll forming machines, some of the most modern aluminum welding equipment in the country and some of the most up-to-date automatic anodizing equipment.

Second, Reynolds Aluminum Fabricating Service, because it has produced aluminum parts for diversified industries for many years, has the necessary fabricating experience. Through this experience has been gained a practically unparalleled knowledge of the fabricating of aluminum parts requiring blanking, embossing, stamping, drawing, riveting, forming, roll shaping, tube and shape bending, welding, brazing and finishing.

Third, Reynolds Aluminum Fabricating Service offers important savings to parts customers in many ways. Most important, parts customers do not tie up their capital in raw material inventory and they do not have to buy "specialized" equipment which might be in use only part of the time. Parts from Reynolds are shipped ready to assemble into final products. This also saves on production losses, rejects and scrap handling and storage.

And fourth, Reynolds Aluminum Fabricating Service offers the services of trained engineers who will help in your design problems. To get this design and engineering assistance, simply call your nearby Reynolds Office or write to Reynolds Aluminum Fabricating Service at the address below.

A free 24-page "Catalog of Facilities" is available by writing Reynolds Aluminum Fabricating Service, 2065 South Ninth Street, Louisville 1, Kentucky. Other catalogs covering Appliance Parts and Roll Formed Shapes are also free on request.

Printed in U.S.A.

(Advertisement)

enough legible drawing. To repeat a favorite of Dr. Kettering, "the covers of drafting text books are too far apart."

There is another aspect to the subject. Many plants have Industrial Engineers who want pictorial drawings for shop use. This is counter to the conventional short cut drafting advocacy. Now there is nothing much more pictorial than a good mechanical drawing when shorn of its surplus views, lines, repetition and "engineering" terminology. Drafting can be the good old basic third angle projection and no code, conventions or typewriter is required. Incidentally, according to William Batts' talk to ASA after his return from the European Accord Assignment, it would take at least 10 years to establish a new drafting system, 60 days to eliminate the confusion from present practice without disrupting the fundamentals.—G. M.

Chicago, Ill.

Ed—We heartily agree with your statements. We hope that you were interested in the article which appeared in the May issue of *Product Engineering*, written for us by Dean Gerardi, of the University of Detroit, in which he discussed the developments involved in formulating national and international standards.

Counseling the Patent Counsel

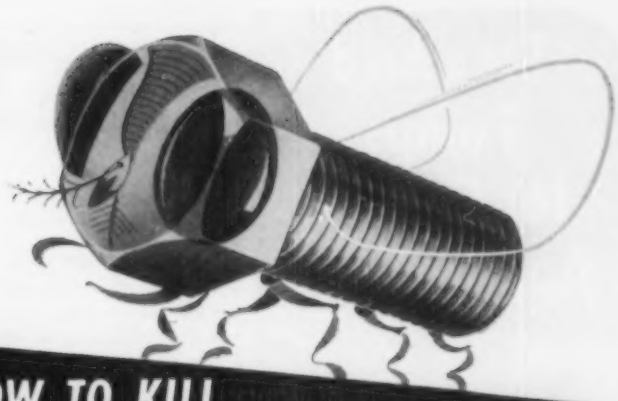
To the Editor:

"Using Your Patent Counsel More Effectively," by Calvin D. MacCracken and James M. Relph, on page 281 of the March issue, is very sound.

There is another advantage to having the patent attorney in on developments as they progress: in the event of litigation, this detailed knowledge is very useful in dealing with expert witnesses called by the other side.

The only reservation I would have to the authors' suggestions is that if an attorney becomes too immersed in a particular field there may be some danger his patent writing can become so full of detail that it resembles an engineering progress report rather than a full but concise disclosure and definition of the invention.

WILLIAM R. MEREDITH
Patent Lawyer
Ottawa, Canada



HOW TO KILL
5 thread fastening bugs in design...

Been Stung BY TOO MUCH WEIGHT? *Heli-Coil*® Inserts permit weight reduction two ways: They require less space than solid bushings. Need no greater boss radius than unprotected thread assemblies. Permit the use of fewer, smaller, shorter threaded fasteners.

Been Stung BY WEAK THREADS? *Heli-Coil* Inserts provide a minimum of 25% greater loading strength than unprotected threads in the same material. You eliminate stripping, even in soft materials such as aluminum, magnesium, plastics, wood, etc.

Been Stung BY THREAD WEAR? *Heli-Coil* Inserts can't wear — therefore no customer complaints about worn threads; field service costs are cut.

Been Stung BY CORROSION? *Heli-Coil* Inserts are corrosion-proof stainless steel or phosphor bronze. They withstand temperatures up to 800°F. indefinitely — won't seize, gall or corrode.

Been Stung BY VIBRATION? Vibration will not loosen *Heli-Coil* Inserts; will not damage insert-protected threads. Fits are inherently better; stresses are more evenly distributed.

When you use *Heli-Coil* Screw Thread Inserts you kill *all five* of these design bugs *at once*.

To find out *why* the *Heli-Coil* Insert method of thread protection is the simplest, most effective, and most practical ... to get all the data you need to design these advantages into your product ... to get free samples of *Heli-Coil* Inserts, use this handy coupon.

*Reg. U. S. Pat. Off.

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146 SHELTER ROCK LANE, DANBURY, CONN.

☐ Send samples and Bulletin 689 — Military Standard Sheets.
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☐ Send samples and Handbook 652, a complete design manual.

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Heli-Coil Inserts conform to official military standards MS-122076 (ASG) through MS-124850 (ASG) and others.

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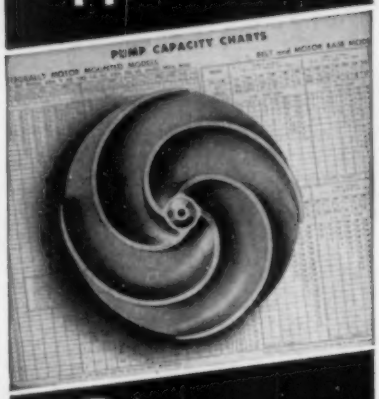

Pioneer PUMPS

IMPELLER TYPES

from 0 to 174 gpm
850 to 3450 rpm

Types available:

Seal and Seal-less

Integral Motor Mounted

Belt and Motor Base

External or Submerged

JIC Standard

Self-Priming Auxiliary Units

Ask for Complete Catalog of Pumps and Accessories

DETROIT HARVESTER Company

PIONEER PUMP Division

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(FACTORY — Paris, Kentucky)

Engineering Catalog Files

W. L. GOVAN
Port Washington, New York

EVERY ENGINEERING DEPARTMENT, drawing office and purchasing department has a catalog file. Catalogs arrive with every mail; of every conceivable size and shape and construction. Some are so small they can only be kept in a desk drawer. Some are so large that they cannot be filed at all. Some are bound on the short edge, or cut into weird shapes.

One or two important facts, hidden in a mass of pages; or at the other extreme, a single thin sheet of essential data. Binders that obscure the innermost words of the text. Binders that are looseleaf in name only; pages cannot be added or removed. Price lists and other supplements, which cannot be attached to the main catalog, and which are not the same size or style. Bindings which project out from the covers, making it awkward to withdraw adjacent catalogs. Loose-leaf binders, with so few rings that the pages are always falling out.

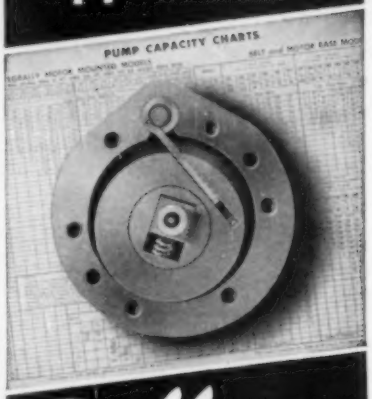
Wedge-shaped binders, very wide at the binding, very thin at the opening edge, guaranteed to twist any file out of shape whether in bookcase, cabinet drawer, or even in an open pile. Dark, glazed covers on which it is impossible to write a filing number, and to which even glue will not stick on a gummed label. Thin covers, which tear off or fold. Covers which are deliberately mysterious, and give no clue to the contents or the manufacturer.

Incomplete Information

Some catalogs have no index or table of contents. Some show no part numbers, or use the illustration figure numbers as part numbers, without explanation. Some have no date, and no publisher's identifying number. Some have to be searched for the manufacturer's name. Some state the city, but not the full postal address; and the telephone number is rarely given.

Some catalogs would grace a living room table but are of no earthly use in an engineering department. They seem to boast that money was no object in their preparation and actually cast doubts on the economic wisdom of dealing with such a high-cost outfit as

Standard Pumps for Custom Applications



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from 1/8 to 60 gpm
200 to 500 rpm

Types available:

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DETROIT HARVESTER Company

PIONEER PUMP Division

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(FACTORY — Paris, Kentucky)

NEW PROTECTIVE COATING CHEMICAL FOR ALUMINUM

ALODIZING

Alodizing with "Alodine,"* a new technique in the protective coating of aluminum, was made available for production-scale use in 1946. Since that time Alodizing has largely supplanted the more elaborate, costly and time-consuming anodic treatments in the aircraft and other industries.

Continuous and successful industrial use has clearly demonstrated the simplicity and economy of the Alodizing process as well as the effectiveness of the "Alodine" amorphous coatings, particularly as a base for paint. In fact, the paint-bond that Alodized aluminum provides has been found to be superior to that possible with chromic acid anodizing.

The corrosion-resistance of unpainted aluminum Alodized with "Alodine" Nos. 100 or 300 is excellent, easily meeting the requirements of Specification MIL-C-5541. However, a need for protection of unpainted aluminum, even better than that obtained with chromic acid anodizing, has long been recognized.

NEW IMPROVED "ALODINE" DEVELOPED By ACP RESEARCH CHEMISTS

Several years of intensive research have now led to a new type of "Alodine," designated as "Alodine" No. 1200. This new protective coating chemical forms an amorphous mixed metallic oxide coating of low dielectric resistance that provides unusually high corrosion-resistance for unpainted aluminum. In addition, it forms an excellent paint bond that approaches closely the high quality obtained with the earlier types of "Alodine."

After having been tested for conformance with Specification MIL-C-5541, "Alodine" No. 1200 is now about to go into production.

PROCESS DETAILS

"Alodine" No. 1200 is the only essential chemical needed to prepare the coating bath and the final rinse bath. One of its unique features is that it can be used in tanks in an immersion process, or, in a multi-stage power washer in a spray process, or, with a slight adjustment of pH, with brush or portable spray equipment in a manual process. This means that even where the simple production equipment is not available, or where touching up of damaged coatings previously Alodized or anodized is required, excellent protection and paint bonding can still be obtained with practically no equipment.

All three methods of application easily meet the requirements of Specification MIL-C-5541.

Process sequence for all three methods of application is the same as for other standard grades of "Alodine" such as Nos. 100, 300, and 600, viz.: 1. Pre-cleaning. 2. Rinsing. 3. Alodizing. 4. Rinsing. 5. Acidulated rinsing. 6. Drying.

Coating time in an immersion process ranges from 2 to 8 minutes and in a mechanized spray process is about 30 seconds. "Alodine" No. 1200 baths are operated at room temperatures (70° to 100°F.) and heating is required only if the bath has gotten cold after a "down" period.

RECOMMENDED USES FOR "ALODINE" No. 1200

"Alodine" No. 1200 is specifically recommended for coating wrought products that are not to be painted or are to be only partially painted; and for coating casting and forging alloys whether or not these are to be painted. "Alodine" Nos. 100 and 300 are still recommended for coating wrought products such as venetian blind slats, awnings, etc., that are invariably painted.

RESULTS OF TENSILE TESTS

This new "Alodine" not only retards visible corrosion and pitting, but as shown in the table below, the loss of ductility with "Alodine" No. 1200, both brush and dip, after 1000 hours salt spray was less than for chromic acid anodizing after 250 hours, and for "Alodine" No. 100 and a conventional chromate treatment after 168 hours exposure.

PROCESS	SALT SPRAY EXPOSURE	COMPLIANCE WITH TENSILE REQUIREMENTS OF MIL-C-5541
CHROMIC ACID ANODIZING	168 hrs.	passes
	250 hrs.	passes
	500 hrs.	fails
	1000 hrs.	fails
BRUSH "ALODINE" No. 1200	168 hrs.	passes
	250 hrs.	passes
	500 hrs.	passes
	1000 hrs.	passes
DIP "ALODINE" No. 1200	168 hrs.	passes
	250 hrs.	passes
	500 hrs.	passes
	1000 hrs.	passes
DIP "ALODINE" No. 100	168 hrs.	passes
	250 hrs.	fails
	500 hrs.	fails
	1000 hrs.	fails
CONVENTIONAL CHROMATE TREATMENT	168 hrs.	passes
	250 hrs.	fails
	500 hrs.	fails
	1000 hrs.	fails

*"Alodine" Trade Mark Reg. U. S. Pat. Off.

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154 varied applications of molybdenum sulfide in the shop and in the field are described in a new booklet now available. This solid-film lubricant has demonstrated unique anti-friction properties under conditions of extreme pressure, high velocity, elevated temperature, or chemical attack.

The 40-page booklet contains the records of solved lubrication problems — some might solve your own. Fill in the coupon below, attach it to your letterhead and send it off today.

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A LITTLE DOES A LOT

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MOLY

PE-6 MS-6A

their issuers must be. Such catalogs may be very good reading; so good that the chief keeps them himself for he does not want everyone wasting time over them.

Attractiveness vs Usefulness

It is strange that while the technical staff usually has a lot to say on the text of a catalog, it is rarely consulted on the format. Too often the intention is to publish an eye-appealing, curiosity-arousing work of art that demands to be read immediately, that is so attractive that it will be left on top of the desk and will never, never be filed away.

The technical recipient of a catalog, however, has an entirely different point of view. While a few catalogs may introduce an outstanding novel product and be read immediately out of general interest, usually the catalog is filed away for use when the need arises. The engineer no more thinks of reading it from cover to cover, than he would an engineer's handbook. It is there for reference, when and if needed.

Until manufacturers as a whole recognize the problems of the recipients of their catalogs and design their publications accordingly, catalog files must be prepared to take any size, any shape, and any type of binding.

Specifications for a Good Catalog

The most satisfactory catalog from the point of view of the man who has to file it and refer to it should be $8\frac{1}{2}$ x 11 in., bound on the long edge. The binding should be durable, and smooth; it should not project beyond the covers, neither in the 11 in. direction nor in thickness. Wire-type or plastic bindings are often objectionable on these counts.

When the catalog is closed, the covers should lie in parallel planes, so that the shape is a rectangular prism and not a wedge. This can be provided in loose-leaf binders by a spacer to hold the covers apart at the opening edge. However, loose-leaf should be avoided unless there is a definite need to insert new pages from time to time to keep the catalog up-to-date.

Despite this, thin catalogs should be punched for standard seven ring loose-leaf binders, and should have ample margin at the binding edge so that even a clamp-type binder will not obscure the illustrations, tables, charts and text. While the department may not favor binding several catalogs together as it means all the catalogs in

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Since 1926. In the application, design and manufacture—pumps, separators, hydraulic accessories

EQUIPMENT FOR FLUID POWER TRANSMISSION

Primary
Oil Pumps
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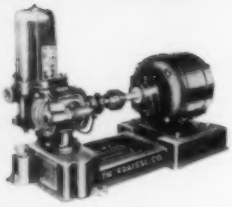

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Kraissl's patented, automatic, force-free lubrication and flushing system makes these direct-drive, high-capacity pumps ideal for the special requirements of bottle-filling machinery.
Air-cooled design — or water-cooled models for heavier duty.
Class 21 roller-action pumps are recommended for handling corrosive gases and extraneous matter that might jam with closer clearances. The multi-blade design of the Class 25 pumps gives higher capacity efficiencies and is designed for applications requiring higher degree of vacuum. Where water-cooling is desired for continuous service, the water-jacketed Class 25-WJ models are recommended.

EXCLUSIVE CLASS 26 AIR FILTER

is available as an integral part of each pump up to 10 cfm — to produce oil-free discharge air and also conserve the lubricating oil.

Write today for Bulletins A-1289 and A-1523

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"Let's talk one-piece construction!"

"We're at the crossroads, Bob. We've got to have more heat exchange capacity, yet we can't afford new equipment. What can we do?"

"Well, you've pretty much answered that question yourself. You said you were at the crossroads—I use that expression to describe the point where using Wolverine Trufin* is more economical than prime surface tube. In other words, Mr. Jones, you should retube with Trufin—the integral finned tube."

"What exactly do you mean—integral?"

"Well, let's talk one-piece construction. You see, fins are extruded right from the tube wall. Because the tube is finned, you get more heat transfer surface in a smaller area. And, because the fins are an integral part of the tube, you get more heat transfer. In short: vibration, temperature shock, pressures can't jar the fins loose. Your problem isn't any different than the one we had a month or so ago. This company had a small stand-by condenser—they also needed to boost their total condensing capacity. So, they retubed the small unit with Trufin and hooked it up in parallel with their larger prime surface unit. Well, production of the smaller Trufin unit equalled that of the larger prime surface installation. As a result, they eliminated the need for an entire new condenser!"

"Boy! If we can only do that, too!"

"You can! I'll outline the idea in a letter to you this afternoon. I can prove that you will save in the long run."

WHEN IT'S TIME TO RETUBE: be sure to consider Trufin. *It pays!* It's available in copper, copper-base alloys, aluminum, bi-metal, electric-welded steel and other metals. And write for a copy of Wolverine's Trufin Data Sheet. You'll find all the information you'll need. WOLVERINE TUBE DIVISION of Calumet & Hecla, Inc., 1479 Central Avenue, Detroit 9, Michigan.

Wolverine Trufin and the Wolverine Spun End Process available in Canada through the Unifin Tube Co., London, Ontario

*REG. U. S. PAT. OFF.

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PLANTS IN DETROIT, MICHIGAN, AND DECATUR, ALABAMA • SALES OFFICES IN PRINCIPAL CITIES

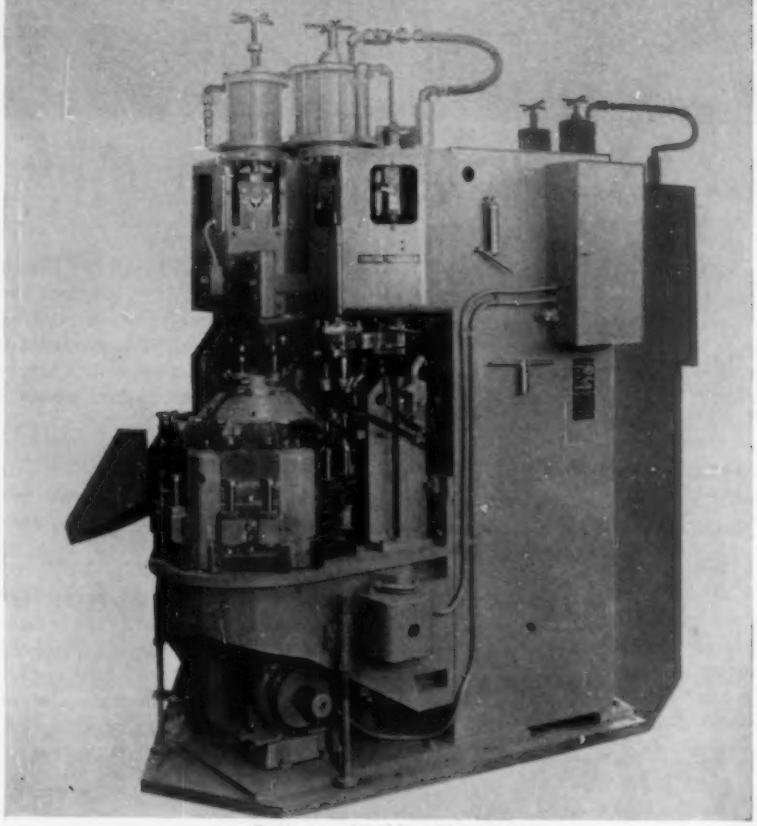
EXPORT DEPARTMENT, 11 EAST 40TH STREET, NEW YORK 16, NEW YORK.

"Let's call in T.W."

"THEIR EXPERIENCE WITH AUTOMATION OF RESISTANCE WELDERS WILL COME IN HANDY ON THIS ONE"

● "What's the best method for automatically loading and unloading resistance welders?" . . . "Can the welders be made an integral part of the production line?" . . . "What mechanical devices can be employed to make resistance welders automatic?"

Automatic resistance welding may be the production key you have been seeking to improve your costs. By calling in T-W you will gain the benefit of their work with automation as applied to resistance welding. One recommendation by T-W application men may make the big difference in your costs. T-W has the facilities, the engineers and the reputation for the best in resistance welding.



Resistance Welders Since 1898

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OAKVILLE AND WINDSOR, ONTARIO

TAYLOR-WINFIELD
RESISTANCE WELDERS

THE TAYLOR-WINFIELD CORPORATION WARREN, OHIO

the binder must be removed from the files by one borrower, thus reducing their availability, nevertheless many engineers prefer binders for their personal files. Manufacturers should provide suitable binders on request, to hold sets of their publications.

Oversize or folded pages and graphs or illustrations spreading right over the inner margin onto the adjacent page (sometimes found in the middle page of the pamphlet) should be avoided.

Catalogs supplied by one manufacturer should be uniform in size and format, and even in coloring. Some manufacturers have recognized this, and have maintained the same style and color of binding and covers issue after issue—their catalogs are landmarks in every engineering department, known by all by sight, even when the name is hidden. Supplements, price sheets etc. should also be uniform with the main catalog and should be attachable by gummed strips, envelope in the cover, or other means.

The cover should have an informative title; the manufacturer's name, and a trade-name or any other name closely associated with the product. If applicable, file numbers according to some standard filing system should be given. Even so, however, provision should be made for adding local file numbers. Light-colored unglazed areas that will take ink readily should be provided on the back of the binding of thick catalogs, and on the top left hand corner of the front cover, and the top right hand corner of the rear cover, so that the numbers can be seen from either side. The areas should be large enough to take a long number parallel to either the long or short edge of the cover. The pages of thick catalogs should be smoothly trimmed so that numbers, etc. can be inked on the exposed edges.

Index Cards Would Help

It would obviously be a great help if the publishers supplied with each catalog the necessary index cards for the numerical index, supplier alphabetical index, and product alphabetical index, including alternative listings. Most of the information could be printed on the cards, leaving a few blanks to be filled in by the user.

The catalog title page or cover should give the date of issue, publication number (bulletin or form number, etc.), full postal address of manufac-

ANACONDA METALS AT WORK

The American Brass Company develops a new kind of brass that cuts polishing time 50% for one manufacturer and improves product appearance for another... makes bronzes that extend the life of many metal parts

Spotlight on high luster at low cost

The high luster on these brass flashlight end caps didn't come naturally. Niagara Searchlight Corp., Buffalo, N. Y., had to buff it on. This was a high-cost operation. Now Niagara uses Formbrite* . . . a new kind of drawing brass that provides a surface far superior to ordinary brasses. Result? Niagara reports a 50% cut in polishing time. Plating and general quality are improved, too. And they find Formbrite easy to form, draw or emboss.

Old age insurance...

It's easy to take out. And you pay no premium. All you do is specify ANACONDA Phosphor Bronze for the many components like those shown. Ten alloys are available in seven forms. All are strong and tough. They bear up under constant wear and flexings, periodic stresses, fatigue and corrosion. They resist abrasion . . . conduct heat and electricity well . . . keep their high elasticity. We'll be glad to help you select the Phosphor Bronze Alloy that's just right for your job.

What's in a nameplate?

According to the Arlen Trophy Co., Brooklyn, N. Y., one of the largest trophy and premium manufacturers in the country, the *appearance* of a nameplate often means the difference between landing or losing a sale. But price is important, too. That's why Arlen now makes their nameplates out of Formbrite. It costs no more than ordinary brasses. Yet, because of its superfine grain structure, it polishes to a bright finish in half the time. Formbrite results in harder, stronger, springier, more scratch-resistant products, too.

8482

Want more information?

Our Technical Department can give you a wealth of information on the properties and applications of Formbrite and Phosphor Bronze. Write to: *The American Brass Company, Waterbury 20, Conn. In Canada: Anaconda American Brass Ltd., New Toronto, Ont.*

*Reg. U. S. Pat. Off.

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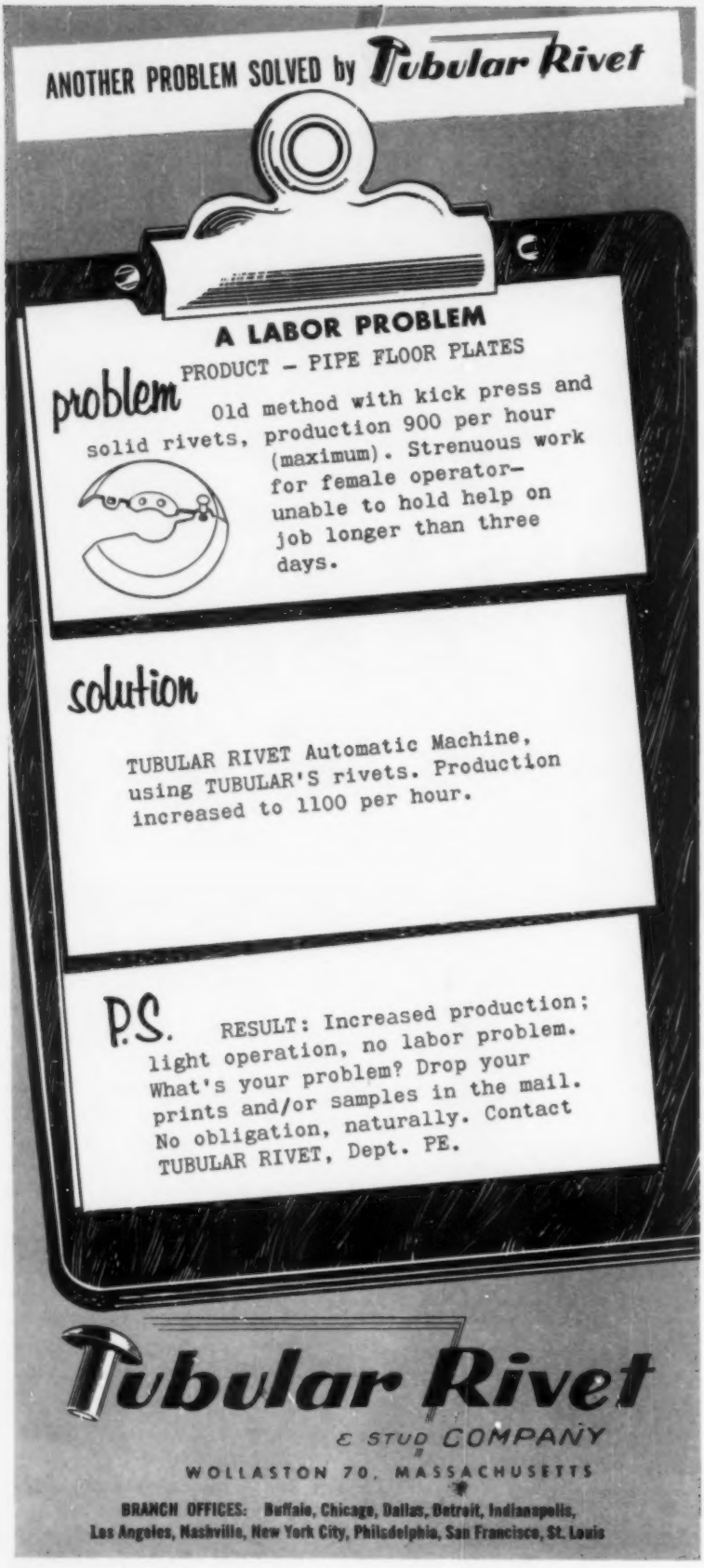
the name to remember in COPPER • BRASS • BRONZE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PRODUCT – PIPE FLOOR PLATES
Old method with kick press and solid rivets, production 900 per hour (maximum). Strenuous work for female operator—unable to hold help on job longer than three days.
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turer, and phone number; name, address and phone of nearest representative (or a space for adding this information), companion publications, superseded publications, associated names such as trade-names, head office, branches, divisions, subsidiaries and sales agencies; and list of products covered by the catalog.

The text should be concise, yet complete. Where practical, the catalog should confine itself to a single type of product. Pages and illustrations should be numbered, and in some cases the paragraphs also. This makes it much easier to refer to details in phone calls or letters. Model and part numbers should be clearly explained, if not self-evident. Unless the catalog is very short, it should have a table of contents and also an alphabetical index. A numerical index of part numbers may also be an advantage.

Many catalogs already approach this ideal, which could be attained by all, to the advantage of everyone.

Precision Milling Done Chemically

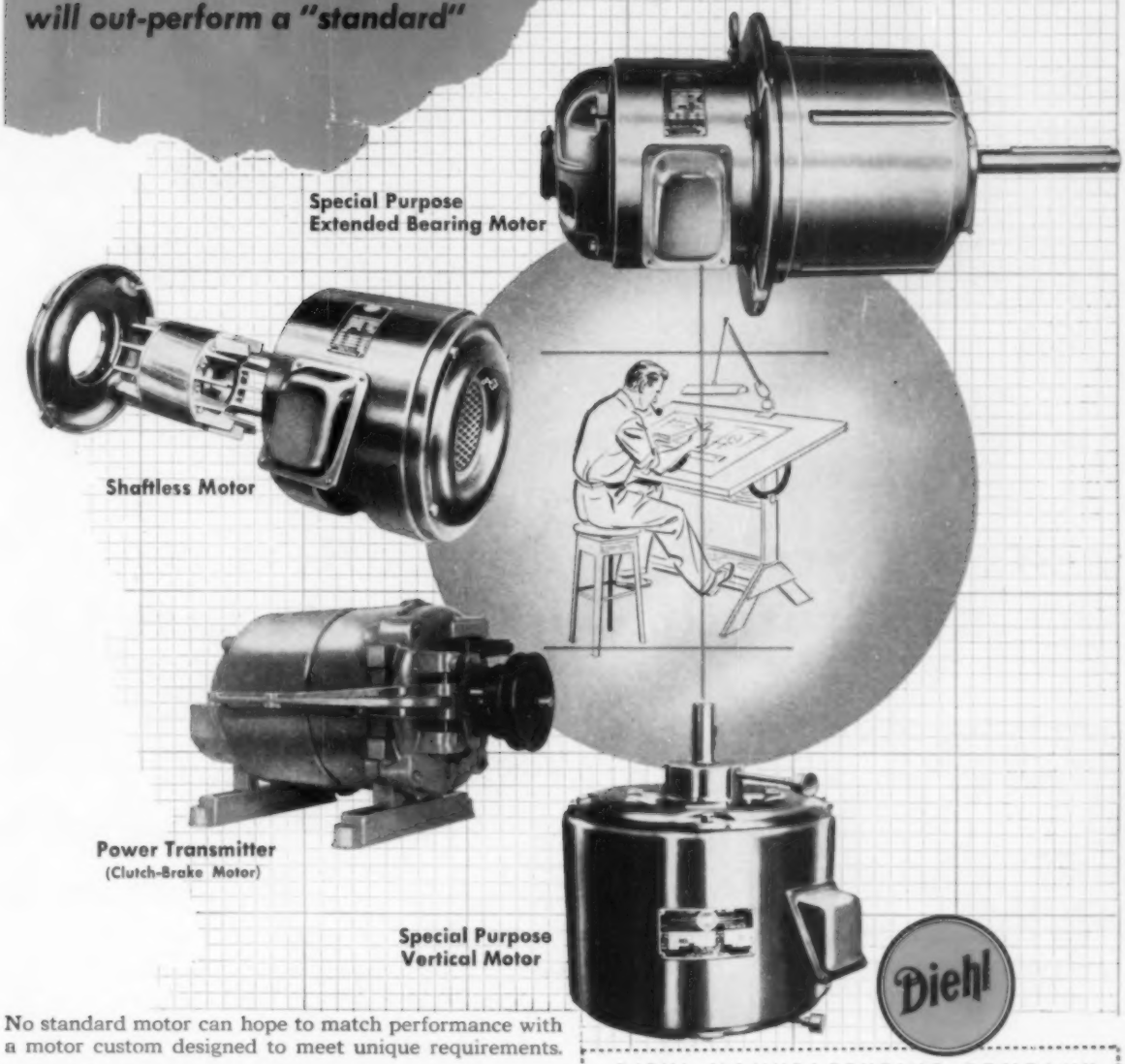
A NEW TERM, "chemical milling," has been added to machining terminology with the development by North American Aviation of this new process. Chemical milling, however, is not intended to replace all machining operations, but to permit new, unconventional designs, and to remove metal from complex or fragile parts without danger of warpage. According to North American, cost of this new process is only a fraction of that for a skin mill.

To prepare a part for chemical milling, the metal to be removed is left exposed, while the rest of the part is masked with a special coating. The entire part is submerged in an etching solution, which attacks only the exposed surfaces at a constant rate. The process is electronically controlled and produces finished surfaces to accuracies of 0.002 in. Perhaps its greatest advantage is that it can produce precision contouring of forgings, or shaped and curved aluminum sheets. With a tank large enough, any number of parts can be etched at the same time.

Most of the experimental work has been done with aluminum, but it has been applied to steel, stainless steel, titanium and others.

a motor designed for its job

will out-perform a "standard"



No standard motor can hope to match performance with a motor custom designed to meet unique requirements.

That's why Diehl lays so much emphasis on custom construction . . . why, through the years, it has geared its abilities and its facilities, its design, engineering and manufacturing functions for maximum cooperation with its customers . . . whatever the application.

DIEHL **custom-tailored motors can:**

Cut costs • Save space • Reduce weight • Improve safety
Simplify design • Speed production • Improve appearance

When you want a fast, thorough answer to an unusual motor problem it will pay you to consult Diehl. Name your conditions . . . Diehl will design and build to match.

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Electrical Division of THE SINGER MANUFACTURING COMPANY
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Please send me the following bulletins:

☐ New Type "D" Motor Bulletin No. PE 3304
☐ Consolidated Catalog & Price List No. PE 3310

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Company_____

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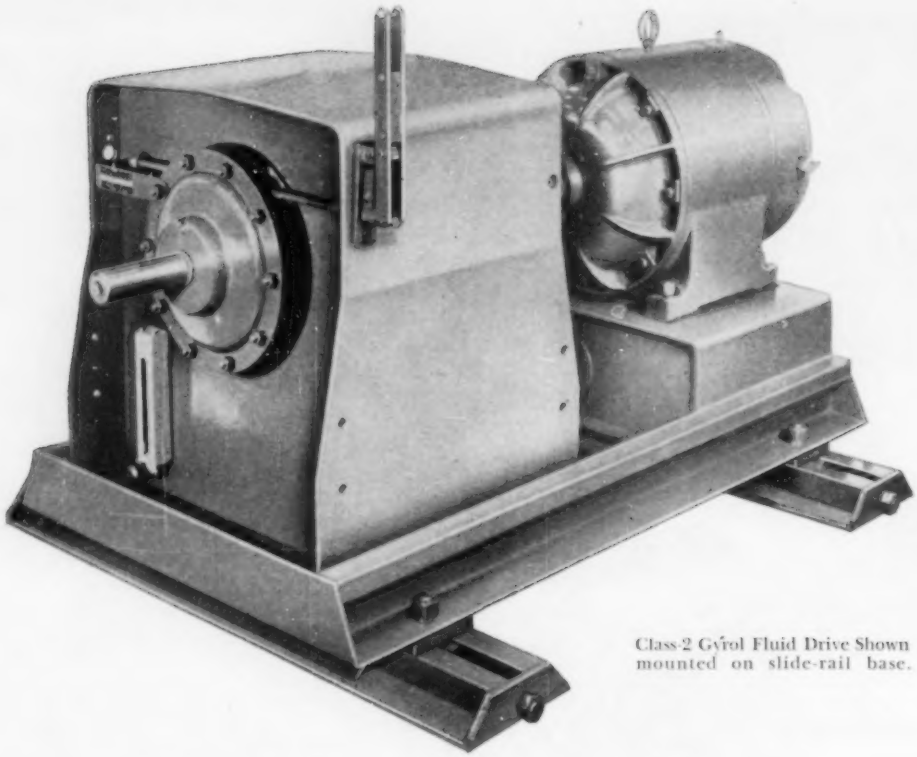
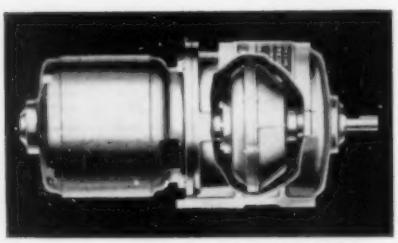
INTEGRAL AND FRACTIONAL HORSEPOWER MOTORS ARE AVAILABLE IN A WIDE RANGE OF TYPES AND SIZES



Class-2 Gyrol Fluid Drive Shown mounted on slide-rail base.

New Gyrol fluid drive offers dual rotation,* adjustable speed



For smaller applications—American Blower TM Constant-Speed Gyrol Fluid Drive. Available in ratings from 1 to 20 hp.

Get the facts today!

Write to: American Blower Corporation, Dept. 180-6, Detroit 32, Michigan. Ask for a copy of Bulletins 9419 and 9519. They will be sent to you promptly along with any other information you may require.

Look at all these features

- *Can be reversed while in motion by reversing motor
- Trigger-action response—adjustable speed
- Speed range 5-1
- Permits across-the-line starting on many applications
- Motor can reach full speed before engaging load
- A compact, self-contained unit
- Speed may be controlled manually or automatically
- Six sizes, 7½ thru 800 hp — speeds up to 1800 rpm

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12 POINTER

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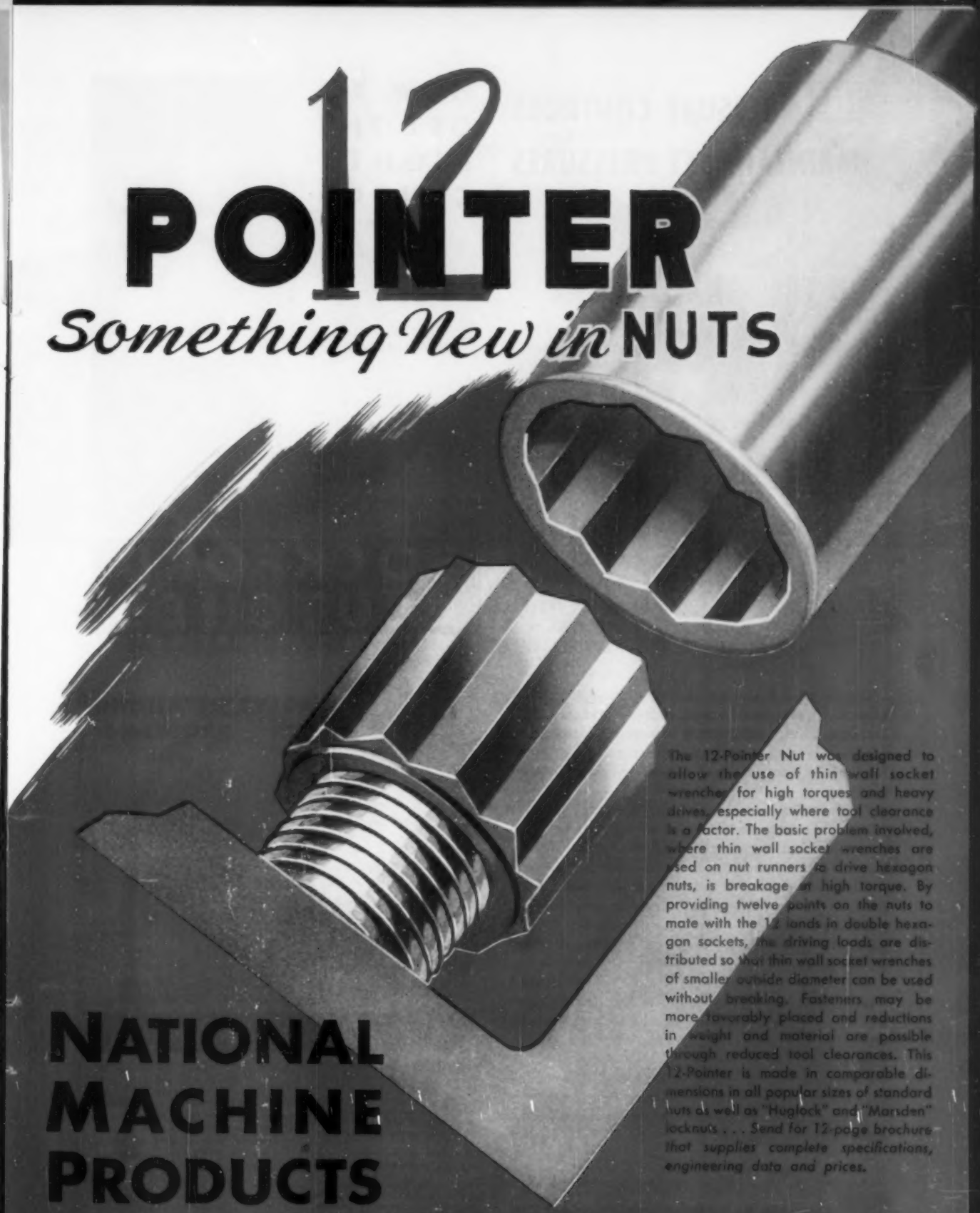

The 12-Pointer Nut was designed to allow the use of thin wall socket wrenches for high torques and heavy drives, especially where tool clearance is a factor. The basic problem involved, where thin wall socket wrenches are used on nut runners to drive hexagon nuts, is breakage at high torque. By providing twelve points on the nuts to mate with the 12 lands in double hexagon sockets, the driving loads are distributed so that thin wall socket wrenches of smaller outside diameter can be used without breaking. Fasteners may be more favorably placed and reductions in weight and material are possible through reduced tool clearances. This 12-Pointer is made in comparable dimensions in all popular sizes of standard nuts as well as "Huglock" and "Marsden" locknuts . . . *Send for 12-page brochure that supplies complete specifications, engineering data and prices.*

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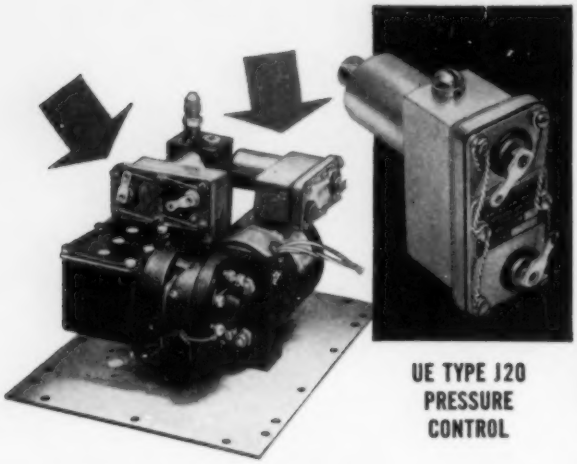
UE PRESSURE CONTROLS MAINTAIN SET PRESSURES IN THE STRATOSPHERE



UE TYPE J20 PRESSURE CONTROL

The electronic equipment in today's high-flying aircraft requires uniform pressure conditions at predetermined levels in order to function accurately. At current operating altitudes, this pressure is supplied by pressurization units made by Eastern Industries, Inc. – and maintained by *UE* Type J20 controls.

The pressurization unit maintains a constant pressure at all times, between predetermined settings, thus assuring reliable performance of the plane's electronic equipment. The *UE* Type J20 Pressure Control automatically cuts the pressurization unit's motor in and out at those predetermined settings – thus assuring optimum electronic performance.

UE Type J20 – now offered commercially for the first time – is also being used in pressurized coaxial cables, R. C. A. ground radar, and in maintaining frequency bands.

United Electric manufactures a wide line of standard controls that are used in aircraft fuel purging systems, paper mill machinery, diesel engines, milk pasteurizers, room air conditioners and in countless other applications.

Special controls can be adapted from standard models, or can be custom built by United engineers working in cooperation with your own product development engineers.

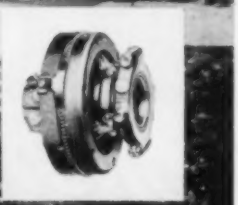
Write today for information on the complete line of United Electric Controls.

Standard and special thermostats and pressure switches

UNITED ELECTRIC CONTROLS CO.

87 School Street, Watertown, Mass.

HOW TO GET THE RIGHT CLUTCH



Whatever your power transmission control requirements may be, your product will benefit by using a clutch that is exactly suited to its need. Thousands of manufacturers — in hundreds of industries — have increased the efficiency of their machines with the right ROCKFORD CLUTCHES. Our engineers are not restricted to any one type or size of clutch — but are free to specify one that is best suited to the particular operating essentials of your product.

Write for our latest bulletin that shows typical installations of ROCKFORD CLUTCHES and POWER TAKE-OFFS, with diagrams of unique applications, capacity tables, dimensions and specifications.

ROCKFORD CLUTCH DIVISION
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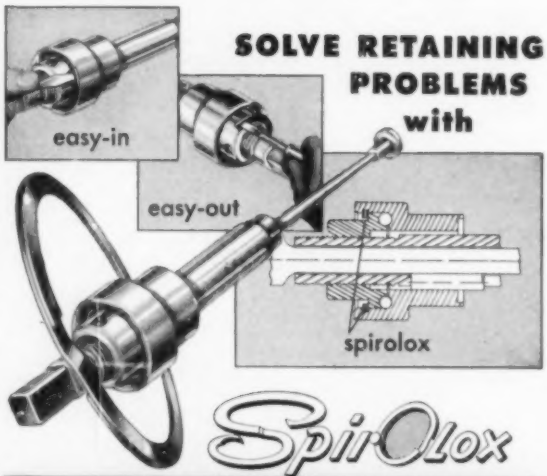
SOLVE RETAINING PROBLEMS with



SpirOlox Retaining Rings

With Spirolox you are assured of quick, easy installation and removal of the retaining ring. As illustrated by this installation on a tube-cutter assembly, Spirolox is inserted in a jiffy, removed with a flip of a screwdriver. No special tools needed.

Simplified, trouble-free solutions to retaining problems like this are possible because of extraordinary Spirolox flexibility and conformability. Unique two-turn construction lets you spiral-in a Spirolox ring quickly and easily. Complete elimination of lugs or projections, breaks or gaps, provides uniform shoulder which conforms 100% to diameter of groove.

SEE OUR CATALOG IN SWEETS FOR PRODUCT OF SIGNERS

FREE DATA BULLETIN tells how you can solve toughest retaining problems with SPIROLOX—send for your copy! Ramsey Corporation, St. Louis 8, Missouri, a subsidiary of Thompson Products, Inc.

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SPIROLOX—the Better Way to Hold Moving Parts TOGETHER!

PHOTO COURTESY GORMAN-RUPP COMPANY, MANSFIELD, OHIO

gallons of water for thirsty acres with modern, thrifty **CHRYSLER V8** *hemispherical combustion*

With irrigation, every farmer and grower can virtually assure himself a record crop *every* year. The investment in pump, pipe and sprinklers pays for itself in a surprisingly short time.

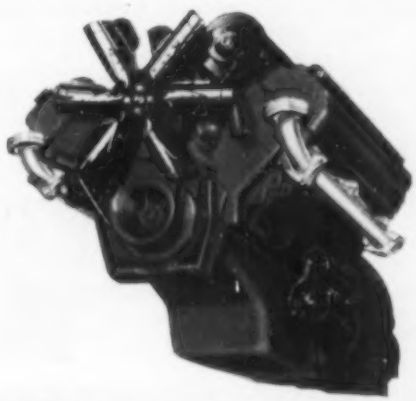
Here is a Gorman-Rupp single-stage centrifugal pump designed especially for portable pipe irrigation systems. It is drawing 850 gallons of water per minute from the river to irrigate several acres of corn. To maintain this gallonage at 130 pounds pressure, its 331 cubic inch displacement Chrysler Industrial Model 24 V8 Engine is turning at only 76 per cent of its maximum governed speed.

Like other leading manufacturers, Gorman-Rupp picks the Chrysler Power that will match its equipment requirements. For example, smaller pumps are powered with Chrysler Model 30 and 16 Engines which deliver ample power for those units; but, since this Model 55M Pump was designed for high capacity pumping, Gorman-Rupp installs the 180-horsepower Chrysler Industrial Model 24 V8 Engine. Result of using this modern short-stroke, low friction engine: High water volume *plus* outstanding operating economy.

Regardless of the type of equipment you manufacture, if it requires industrial power within our 230 to 413 cubic inch displacement range, there's an economical power-proved Chrysler Industrial Engine to meet your requirements, and a long list of optional equipment items with which your engines can be factory-equipped for *better* specialized performance.

And remember, Chrysler Power is not expensive. Production-line methods adapted to specialized industrial engine building provide a custom-built engine at mass-production prices.

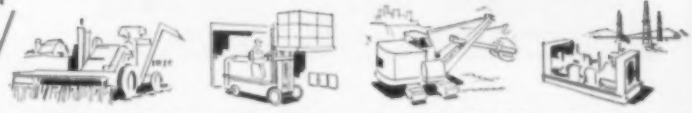
Before you install any engine, see a Chrysler Industrial Engine Dealer or write for detailed information: ***Dept. 56, Industrial Engine Division, Chrysler Corporation, Trenton, Mich.***



CHRYSLER *Industrial Engines*

INDUSTRIAL ENGINE DIVISION • CHRYSLER CORPORATION

HORSEPOWER WITH A PEDIGREE



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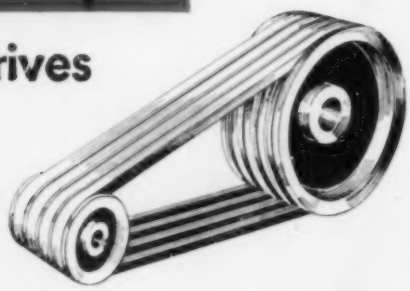
v-drives



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The chances are better than even that your V-Drive requirements can be met in full from the complete stocks of Cast Iron and Pressed Steel V-Pulleys, Sheaves, V-Belts and drive parts in the complete Maurey Multiple and FHP V-Drive lines. If you require special sizes or designs of V-pulleys, sheaves or parts, Maurey is staffed and equipped to meet your needs and stay within your budget.

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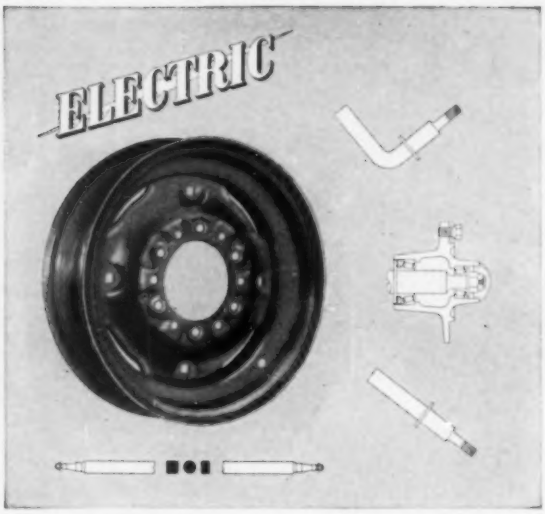

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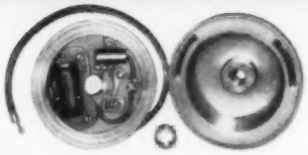
FAIRBANKS-MORSE FLYWHEEL MAGNETOS



These new magnetos are of simple design —compact—few parts —easy adjustment and service. They simplify your production because they are designed for your engine—easily installed.

Molded heavy-duty high tension coil, large, long-lasting breaker points and Alnico permanent magnets are just a few of the features that assure easy starting and peak performance for your engine. Call on us for engineering help. The benefits of our experience gained in building over 3½ million magnetos along with our resecrch and testing facilities are yours upon request.

Get all the facts on Fairbanks-Morse Flywheel Magnetos plus application assistance. Write Fairbanks, Morse & Co., Magneto Division, Beloit, Wisconsin.

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New Taylor laminates

are premium in everything but price

YOU'LL LIKE everything about this new family of Taylor paper-base laminates—including their price. They're a new kind of hot-punch laminate, uniform all the way through, with no surface overlay of resin.

In insulation resistance, water absorption, power factor, flame retardance and dimensional stability, they'll meet or exceed your strictest specifications. And they punch and stake so well . . . with smooth surfaces and clean edges . . . that you can produce complex parts with maximum utilization of each sheet.

Four different grades are available in production quantities, in standard sheet size of approximately 49″ by 49″:

XXXP-301 . . . *the top grade laminate* with unusually high insulation resistance, lowest water absorption . . . excellent punching and staking.

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Taylor Fibre Co. Plants in Norristown, Pa.; and La Verne, Calif. *Branch offices in Atlanta; Boston; Chicago; Cleveland; Dayton; Detroit; Indianapolis; Los Angeles; Milwaukee; New York City; Philadelphia; Rochester; San Francisco; St. Louis; and Toiland, Connecticut. Distributors in Grand Prairie and Houston, Texas; Jacksonville, Florida; New Orleans, Louisiana; and Toronto, Ontario.*

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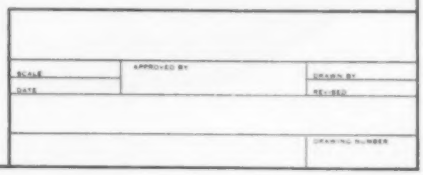

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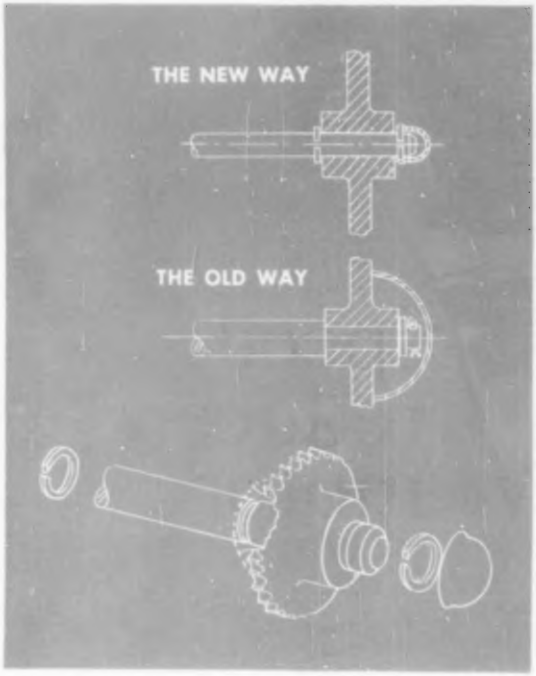

Simple little retaining rings...

1. **shorten assembly time**
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3. **reduce weight**
4. **cut down needless space**
5. **save material**
6. ***increase ultimate profit*** **— and frequently *improve* his product at the same time.**

The world admires not only our unparalleled mass production, but our ingenious designing and *redesigning* which constantly improve and simplify *without* sacrificing strength and complete dependability.

Practically every manufacturer can improve his product—and his ultimate profit—by redesigning his machines and the construction details of his products.

The use of these inexpensive yet efficient artificial shoulders is already widespread—and is increasing constantly.

Every product—metal, wooden or plastic—should be examined carefully to see where shoulders and collars could be redesigned to use these steel rings.

Write today for descriptive booklet.

THE NATIONAL LOCK WASHER CO.

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NEW speed reducer motor

FOR INSTRUMENTS AND CONTROL APPARATUS

¶ The new Bodine Type K-2RM speed reducer motor is designed for continuous duty industrial applications requiring sturdy construction and exceptional reliability. *An outstanding design innovation for this type of motor is the helical gearing* which provides increased load carrying capacity, reduces noise through smoother tooth action and produces more uniform pitch line velocity, as compared to spur gears.

¶ Speeds range from 280 to 0.7 RPM. with torque ratings from 2.7 to 120 inch ounces. Available windings are either synchronous or non-synchronous, and are distributed for highest efficiency. Motor has three leads and is reversible. Dimensions are 2⅜" x 2⅜" x 2 17/64" to 3 33/64" long.

¶ Bodine has had over ten years experience with the basic Type K fractional horsepower motor, which is used extensively by industry with phenomenal success. The new, heavy duty K-2RM motor is the result of this specialized experience and Bodine's 49 years in the fractional horsepower motor field. *Write, today, for complete information.* Feel free to take full advantage of Bodine's qualified application engineers for sound motor counsel.

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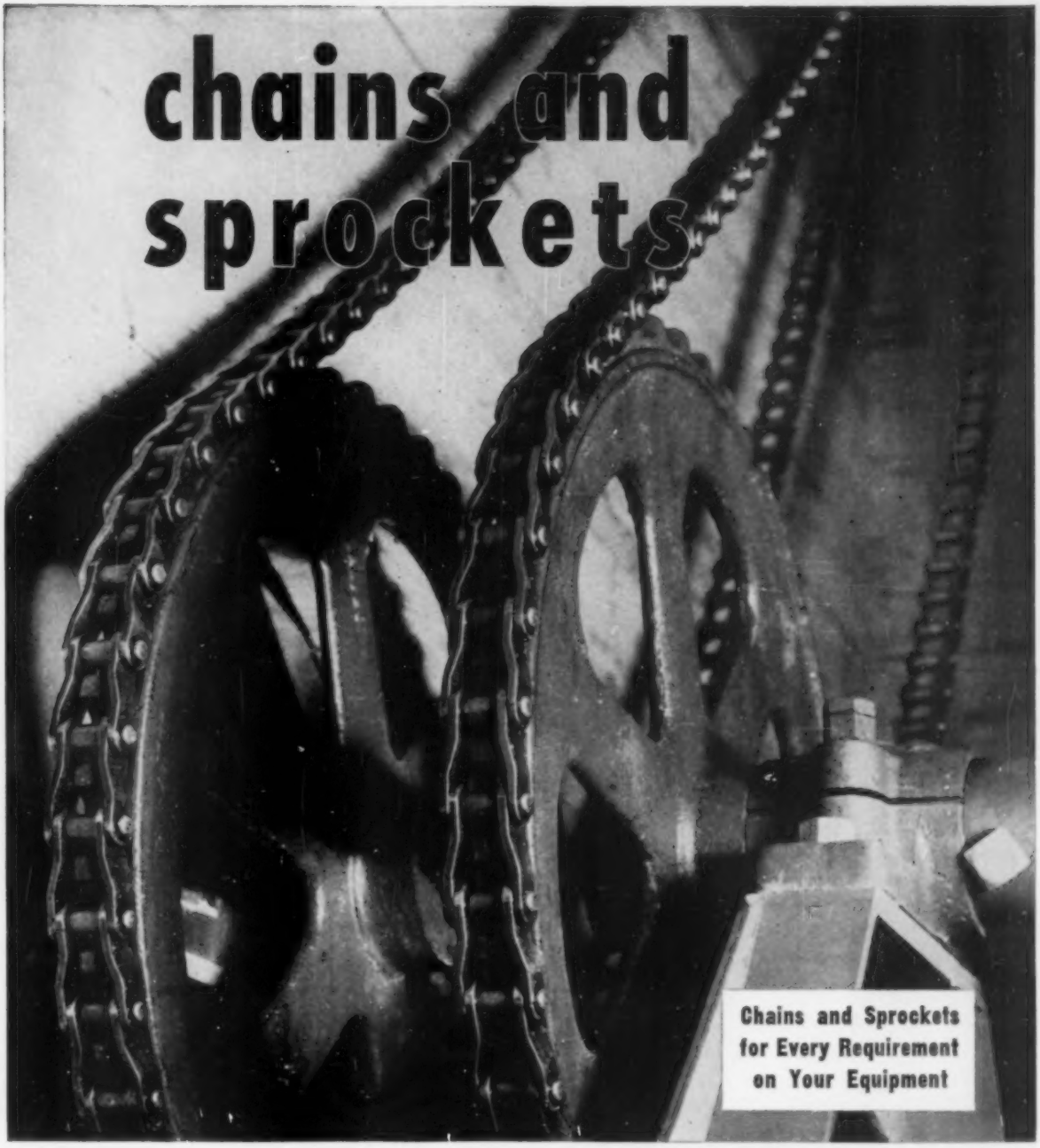

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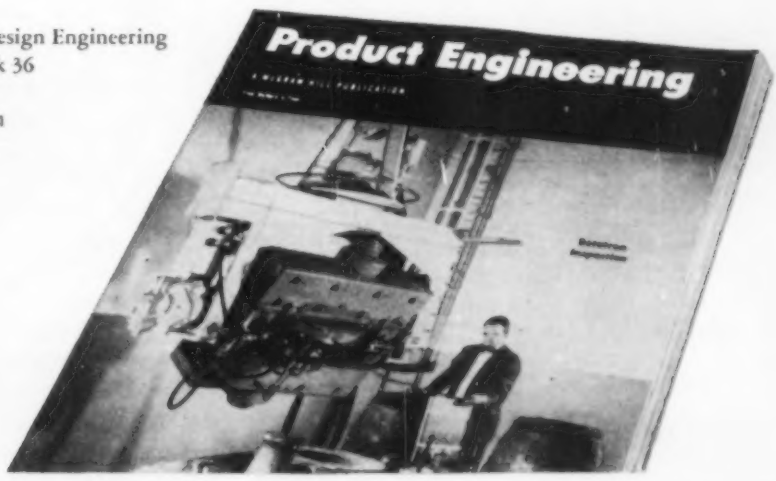

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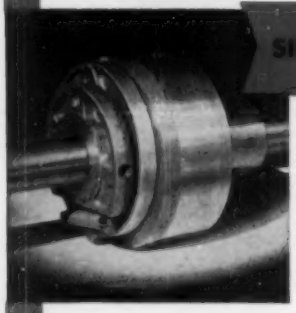

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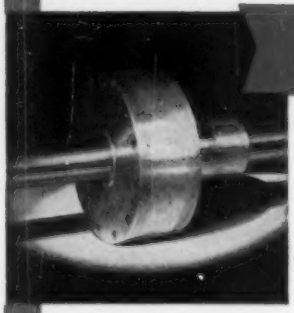

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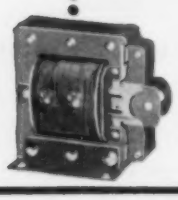

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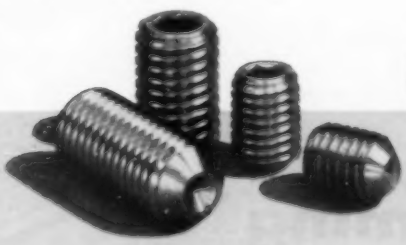

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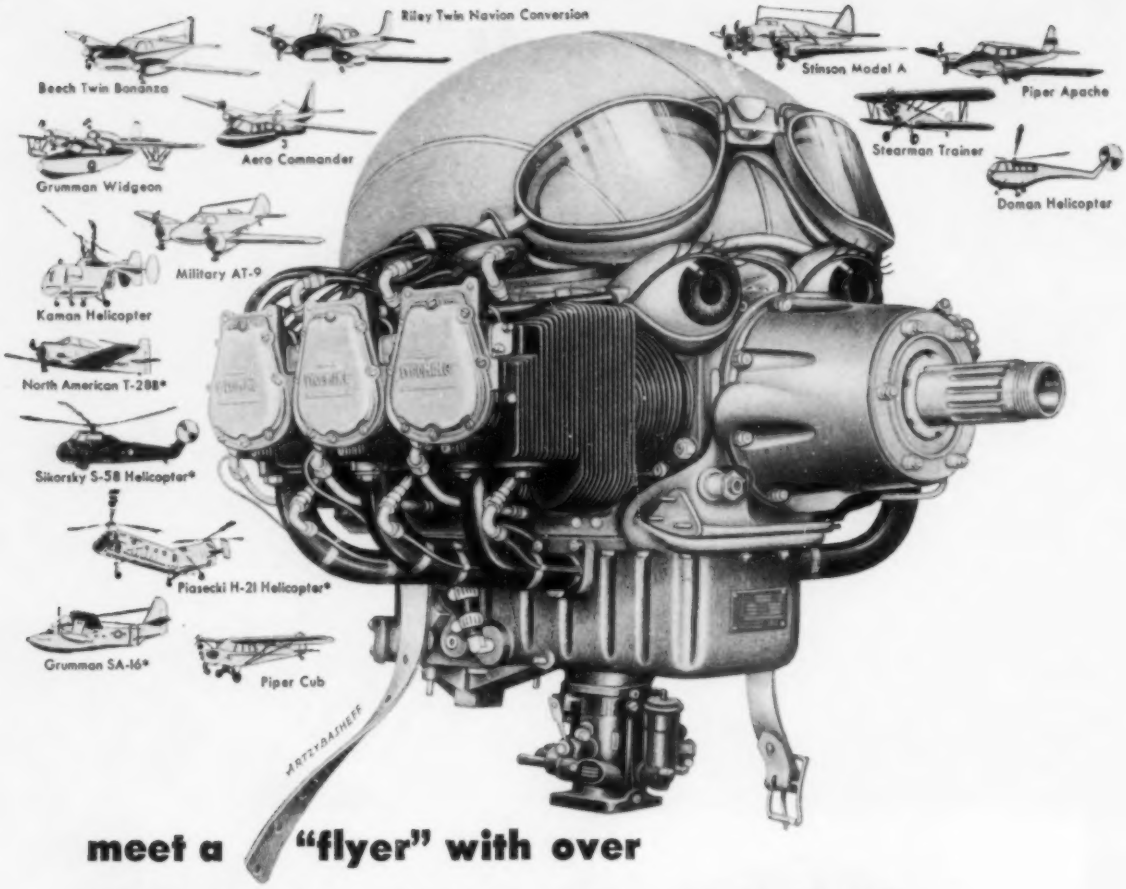

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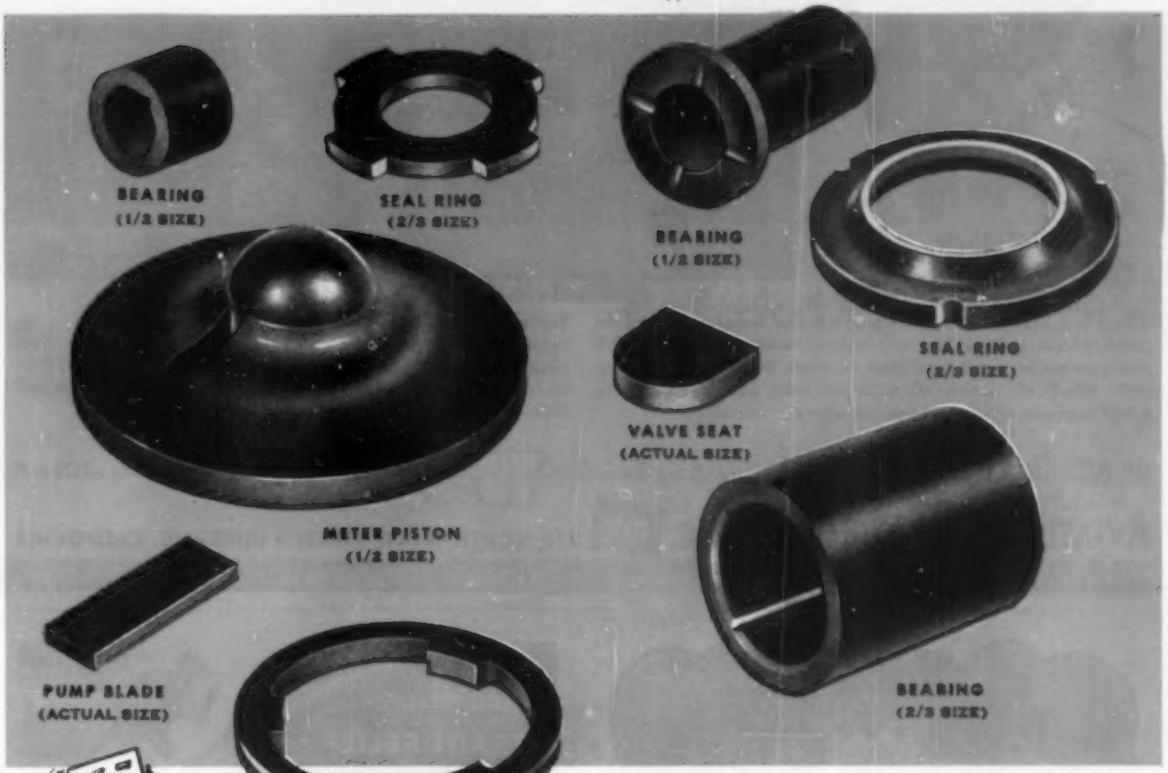

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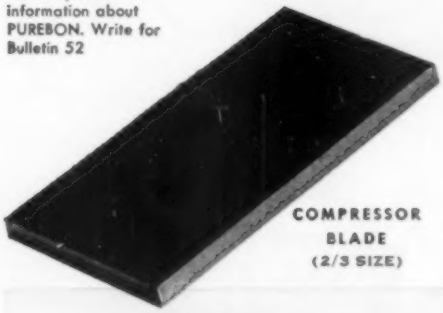
Purebon is the designer's solution to many knotty problems involving sliding or rotating parts where lubrication is difficult and sometimes impossible. Purebon parts are molded or machined exactly to our customers' specifications here in our own plant, under our close supervision and inspection. *Because of the diversified characteristics of Purebon, applications are limited only by the designer's imagination.* If you have a problem involving insufficient lubrication at critical points of friction, our design engineering department will be happy to work with you toward its swift and successful solution.



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Tolerances of approximately 1½% of dimension required for molding most shapes.

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Varies with grade of Purebon.

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Transverse strength varies from 4,000 to 13,000 lb./sq. in. according to grade.

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Tolerances as close as .0005 can be maintained where required.

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Resistant to attack by chemicals of all kinds, used in food handling and processing equipment.

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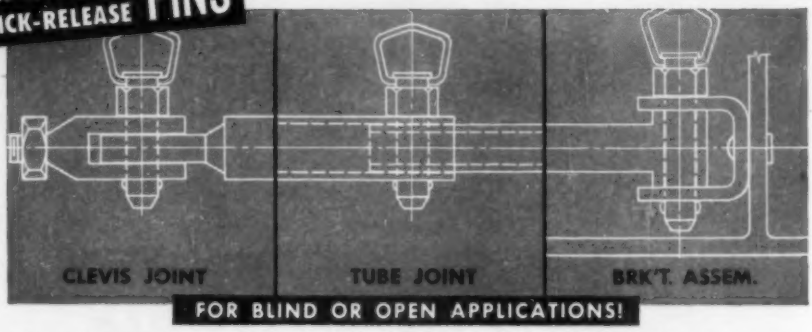

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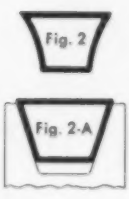
When a V-Belt bends, you can feel its sides change shape.

—just make this simple test

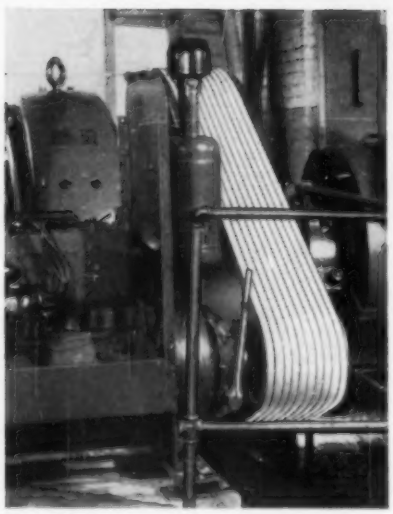
Take *any* V-belt that has *straight* sides (Fig. 1). Bend that V-belt while you grip its sides with your fingers. You will *feel* the sides *bulge out* (Fig. 1-A). Clearly, that out-bulge forces the belt to press *unevenly* against the V-pulley—and this *concentrates* wear at the points shown by arrows (Fig. 1-A).

Now bend a Gates Vulco Rope with CONCAVE SIDES (Fig. 2)

(U.S. PAT. NO. 1813698)



Instead of *bulging*, the precisely engineered CONCAVE SIDES merely *fill out* and become perfectly straight. This belt, when bent, *precisely fits* its sheave groove (Fig. 2-A). The sides of the Gates Vulco Rope press *evenly* against the V-pulley. Therefore, wear is distributed *uniformly* across the *full face* of this belt —resulting in *longer* belt life and *lower* belt *costs* for you!



Typical Gates Vulco Rope Drive —the Gates V-Belts are built with Concave Sides to insure longer belt wear.

When you buy V-belts, be sure to get the V-belt with the Concave Sides—the Gates Vulco Rope!

Gates VULCO ROPE DRIVES

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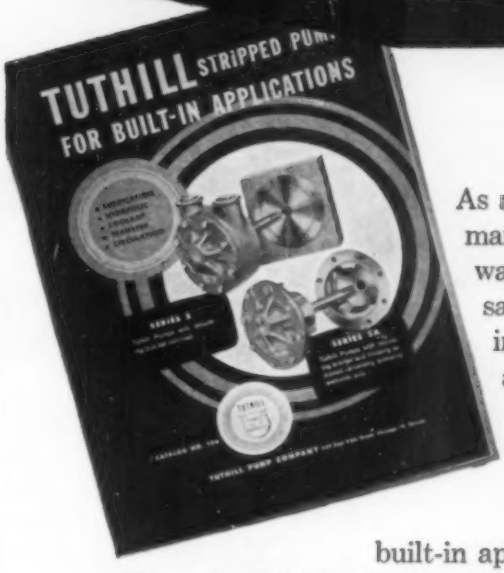

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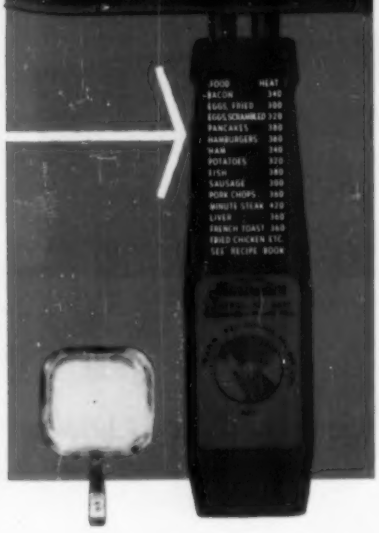

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Metal-Cal is .003-inch aluminum foil, applied with a pressure-sensitive adhesive that bonds to any smooth cohesive surface. The design is created in brilliant dyes, absorbed and sealed into an anodized surface. Metal-Cal gives you bright, *lasting metal* for your nameplates, labels, or other marking needs. No costly drilling, screws, rivets when you use Metal-Cals.

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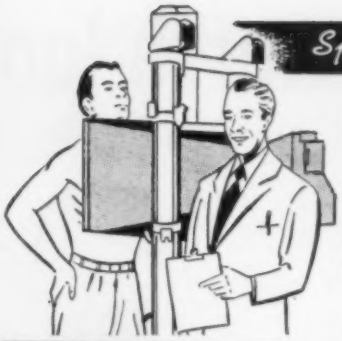

Speeding X-Ray Photography with EEPCO-DESIGNED MOTORS

Manufacturing X-Ray equipment calls for precision and dependability in every part.

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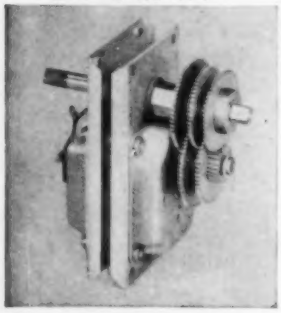
These tiny motors of 1/500 h.p. (intermittent service) provide the reliable, steady source of power that revolves the negative changing mechanism. After a photo is made, the exposed negative with its lens and shutter, are automatically moved aside and a new unit moved into the ready position. Handling this task demands an even, slow application of power to avoid damage to the delicate mechanism. This is typical of the many unusual applications to which EEPCO-designed motors have been put.

If your particular problem calls for special design, or merely for standard motors that can handle the toughest service, you'll find that EEPCO is the source on which to depend. Out of the many unusual requirements filled by EEPCO engineers has come experience unsurpassed in industry and always at your disposal.

Equally important, the EEPCO plant is well-equipped and staffed to turn out motors for you on a mass-production, low-cost basis when necessary.



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609 W. LAKE STREET, CHICAGO 6, ILLINOIS

• P-M DC MOTORS & GENERATORS • CAPACITOR TYPE MOTORS • UNIVERSAL MOTORS
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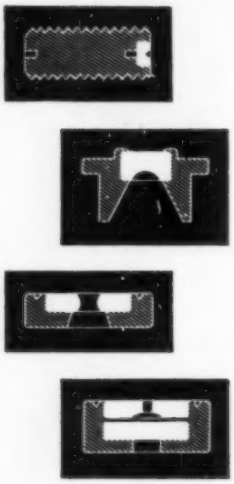
Bird COMPLETE JEWEL ASSEMBLIES WILL SPEED YOUR PRODUCTION



You'll be time and money ahead if you specify Bird complete jewel assemblies for your product. Rejects are eliminated, jewel breakage is minimized, and Bird jewel assemblies will keep your production running smoothly.

Bird Jewel Assemblies are furnished in the right mounting, rigidly inspected according to your specifications, ready for your assembly operations. Make a test — find out how Bird Jewel Assemblies can help your production. Send us a print of your specifications, and we'll provide samples for your own testing.

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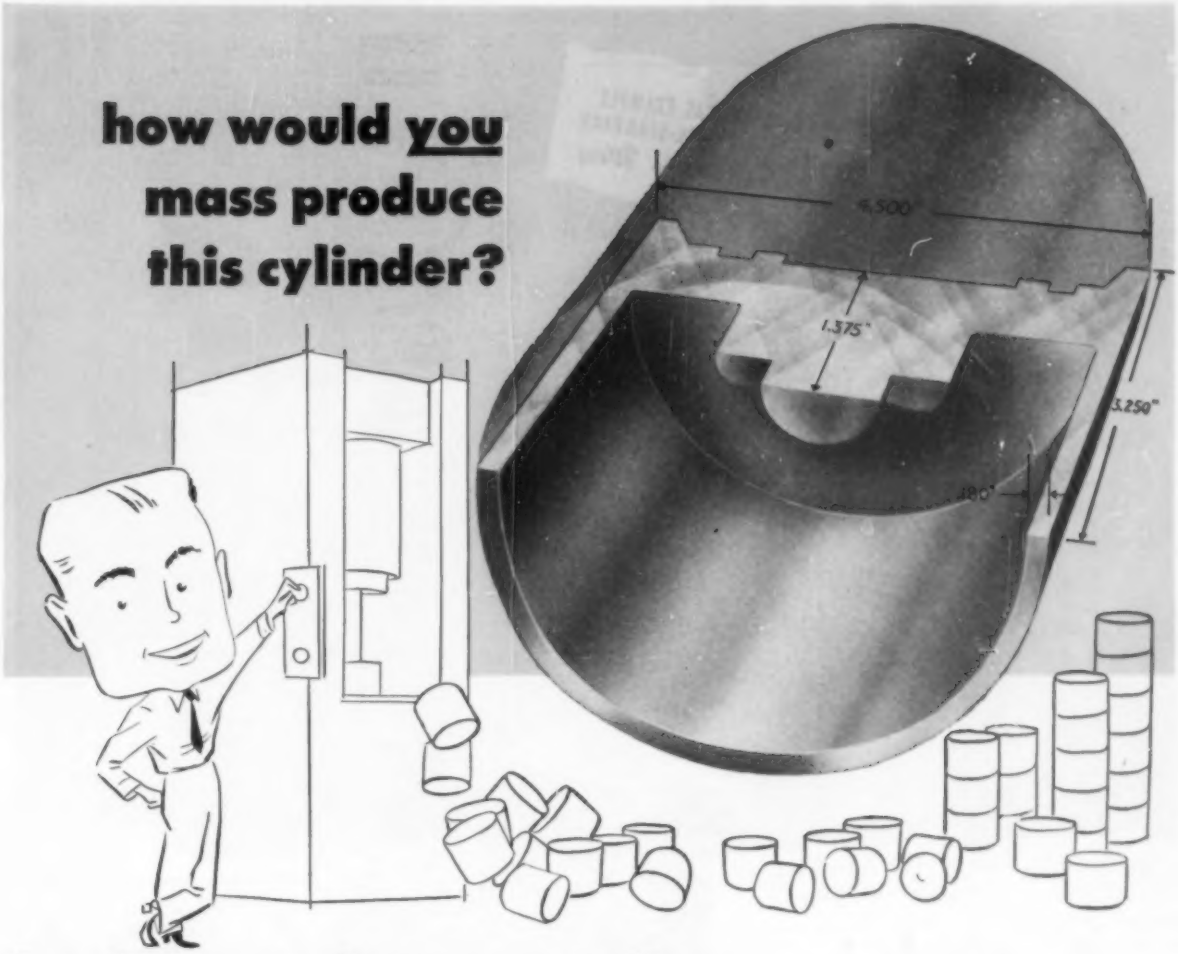

For efficiency and economy specify . . .

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FROM

HIGH STRENGTH ALUMINUM ALLOYS

Strength requirements of this cylinder were satisfied by using a heat treatable aluminum alloy (minimum yield 55,000 P.S.I.). By the Hunter Douglas cold Impact Forging technique, this high strength aluminum alloy was forged in a single operation to the desired shape. . . mass production at its finest. . . with close dimensional tolerances, forged grain flow and walls of zero draft.

The raised stud in the center of the piston offered an added design problem that, by any other process, would present a tremendous time consuming contour milling operation, in addition to high metal waste. The economic advantages of producing this part with minimum metal waste and in a single forging operation are immediately evident. When you are designing a part with the following characteristics:

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Photo courtesy of Woodall Industries, Inc.

A stitch in metal saves *plenty!*

STITCHING with wire is a relatively new way of joining metal to metal, or metal to almost any other material. Since speeds up to 100 stitches a minute are possible . . . and since wire is economical . . . there are tremendous time-and-cost savings compared with other methods of fabrication.

Success of the whole idea hinges largely on special wire. For the wire must be *stiff* to penetrate metal. It has to be *strong*, up to 330,000 psi in tensile strength, to provide a lasting grip. Still it must be *ductile* to take tight 180° bends without cracking or breaking.

Here, at our Worcester Wire Works Division, this unusual wire is produced in several strengths, sizes and finishes to meet all metal stitching requirements perfectly! Here too, the skill and care for which Worcester Wire Works has long been known result in exceptional uniformity — a particularly great advantage for any user of machine-fed wire.

Do you have a problem involving wire? Perhaps, as in metal stitching, a new, specially developed wire is the answer. Maybe you need only some specialized engineering help on the use or fabrication of wire. In any case, Worcester Wire Works stands ready to serve you, to give you the advantage of engineering experience, special skills and techniques that have been over 30 years in the making. It's your standing invitation to out-of-the-ordinary, personalized service in wire.

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DIVISIONS OF NATIONAL-STANDARD CO.

ATHENIA STEEL	*Clifton, N. J.*	Flat, High Carbon, Cold Rolled Spring Steel
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THE MARK OF AN EXTRA DEPENDABLE INDUSTRIAL MACHINE

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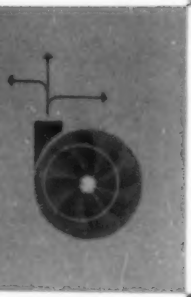

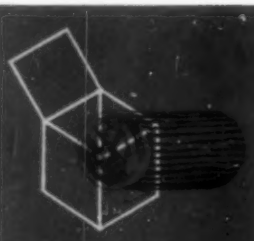

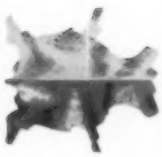

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design fasteners?

When they lower production costs. Southco Fasteners are designed for specific, not general, requirements to reduce installation time, to do a better job.

Southco engineers are available to help you select the right fastener for your particular needs. Write for the Southco Fastener Handbook.

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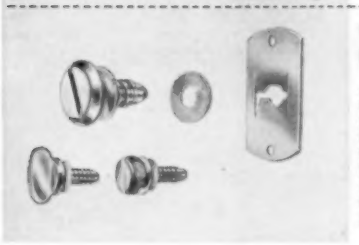
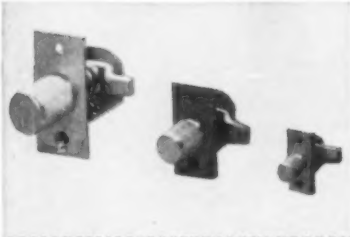
DRIVE RIVETS . . . installed with only a hammer

Make riveting as easy as nailing; a one man job out of a two man operation. For blind or access applications. Fasten metal-to-metal or metal-to-wood. Installation is quick, easy. Just hit the rivet pin with a hammer.



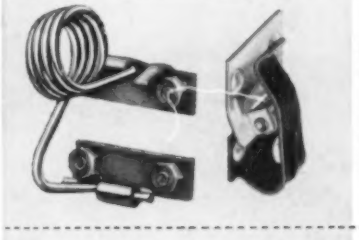
WIDE-TOLERANCE QUICK RELEASE FASTENERS

Ample length tolerance permits one size to cover wide variations in metal thickness and spacing. Simplify stock requirements by eliminating assortment of fastener sizes to accommodate variations in thickness. Floating screw assembly solves alignment problems. Easily installed.



DOOR FASTENERS . . . with adjustable grip

Accommodate variations up to 3/8 inch in engaging distance. Grip pressure adjusted by simply turning the knob. Pre-assembled unit is easily and quickly installed. Two head styles—flush or projecting.

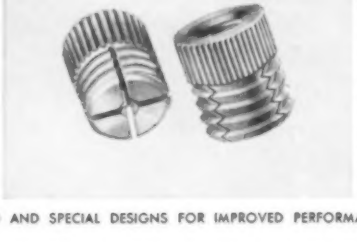


DOOR SPRINGS . . . hold doors open and shut

Good for the life of the assembly. Hold doors both open and closed. Spring tension prevents rattle. Minimum space required. Available in coil or leaf springs.

DOOR LATCHES . . . installed in seconds

Low-cost, rugged, installed with unbelievable speed. Provide positive locking wherever used. Two types—handle or flush-head.



PERMANENT STEEL THREADS IN WOOD

Anchor nuts provide threads for metal screws, bolts, studs. Permit quick attachment or removal of parts as many times as required. Expansion takes place inside wood, wood laminates or composition materials; nothing projects to mar finished surfaces. Can't twist or pull out. Installation is easy.

SOUTHCO®
FASTENERS

OFFICES IN PRINCIPAL CITIES

WHEREVER TWO OR MORE PARTS ARE FASTENED TOGETHER; STANDARD AND SPECIAL DESIGNS FOR IMPROVED PERFORMANCE AND LOWER PRODUCTION COSTS

EVEN THE BEST CAN BE IMPROVED

Gerotor offers its *New QDB* series of small capacity pumps as proof!

Gerotor has redesigned its series of small capacity pumps to give even more . . .

- **FLEXIBILITY**—the QDB can be operated in either clockwise or counterclockwise direction by simply changing the position of one internal plug!
- **RANGE OF APPLICATION**—the QDB can be obtained with an extended shaft to operate another pump in tandem, off of one motor!
- **DEPENDABLE SERVICE**—the QDB is built to give more dependable service over a longer service span than any comparable pump. Its longer life reduces your maintenance and replacement costs.

If you have need for pumps in the QDB range, call on Gerotor.

Gerotor makes a complete line of hydraulic pumps in ranges from .4 g.p.m. to 40 g.p.m. The Gerotor engineers can help you solve your hydraulic pump problems. Write for *free literature* and full particulars.

Check this capacity table . . .

Type	Delivery g.p.m.—1800 r.p.m.				
	Discharge Pressure p.s.i.				
	0	250	500	750	1000
QDB .4	.42	.40	.38	.35	.31
QDB .75	.84	.80	.78	.73	.66
QDB 1.5	1.67	1.62	1.57	1.50	1.42

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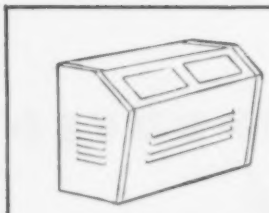
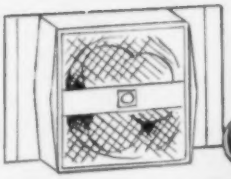
GEROTOR
HYDRAULIC PUMPS & MOTORS



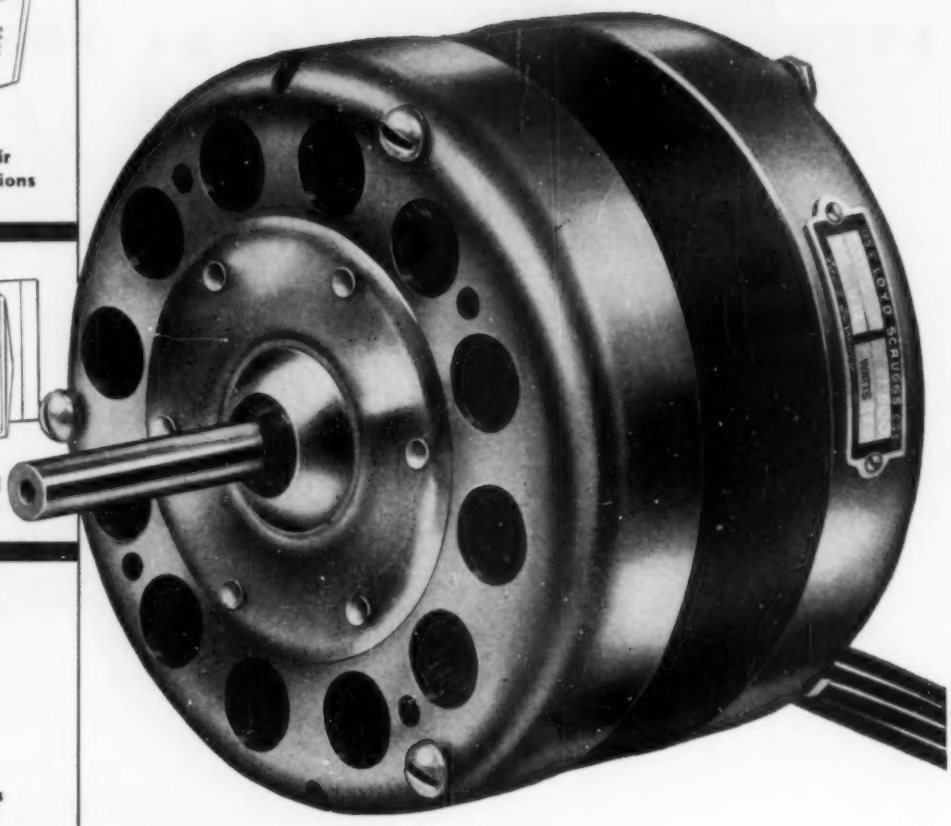
Perfect in room air conditioner applications



Many successful fan applications

?

Potential savings in your product!



Look closely...this new LOYD SCRUGGS 6-pole shaded pole motor may be your answer!

The *new* motor shown above is typical of Scruggs' fast-growing versatility in the fractional horsepower motor field.

The precision standards of Scruggs motors, proven in Dictaphones and many other famous products, are more rigid than ever. But new plant facilities at Festus, Mo., now permit faster deliveries, wider scope and very competitive pricing.

If you're searching for a maker to custom-build your motor, search at Scruggs . . . a sample motor made to your specs can be furnished immediately. Send today for detailed data and performance chart.

You can stake your reputation on SCRUGGS MOTORS.

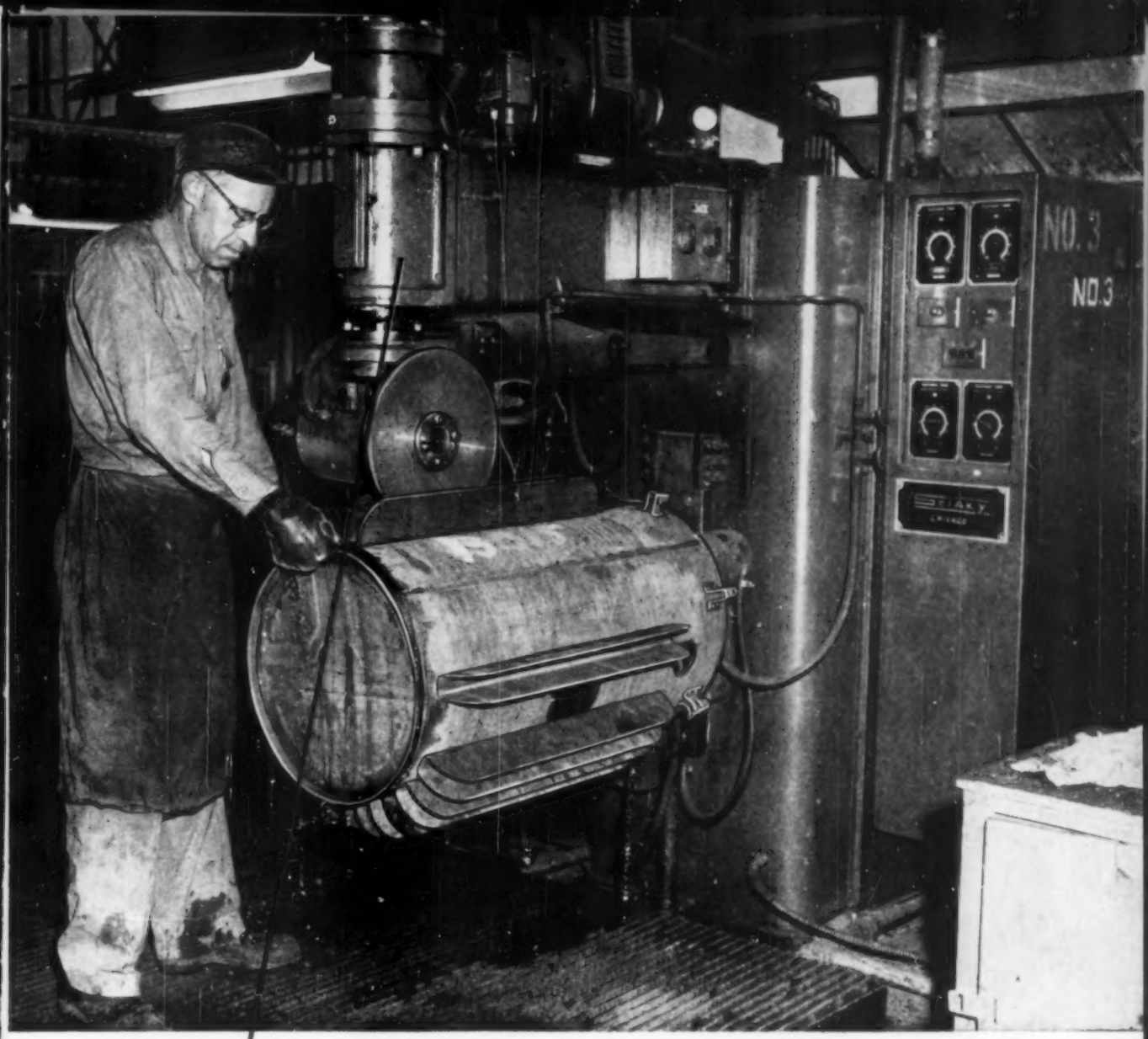
CHECK THESE QUALITY FEATURES:

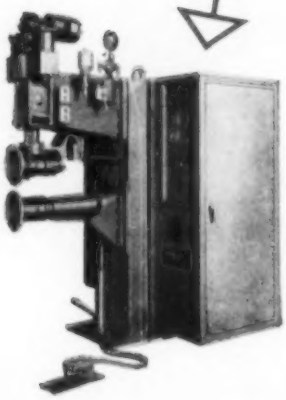
1. Copper-weld rotor for uniform performance
2. Long-life sintered bronze bearings
3. Extra large oil reservoirs
4. Extremely quiet running
5. Rotor electronically balanced
6. Double varnish impregnated for tough applications
7. Design practically eliminates AC hum

THE Loyd Scruggs COMPANY

Festus, Mo.—A Dazey Corporation Subsidiary

MANUFACTURERS OF PRECISION INSTRUMENTS SINCE 1934





Design Change for Resistance Welding Improves Product, and Lowers Cost

A design change of the cooling fin for their distribution transformer tank enabled Moloney Electric of St. Louis, Mo., to substantially increase production, improve their product, and lower fabricating cost with Sciaky resistance welding. Previously, an "L" shaped fin required two complete passes to arc weld. The quality of the weld and cooling efficiency of the fin depended upon a skilled arc welder. A design change to a "U" shaped fin permitted an *unskilled* worker to resistance seam weld *two* cooling fins with only one rapid pass. The seam weld maintained surface contact for maximum heat conductance, while providing twice the cooling area and reducing fabricating time and cost. For complete details write for R.W.A.W. Vol. 3, No. 7.

The improved design of the cooling fins offers another fine example of Sciaky's basic thinking—welders designed to do *more useful work* at *lower operating cost* with *maximum reliability*.

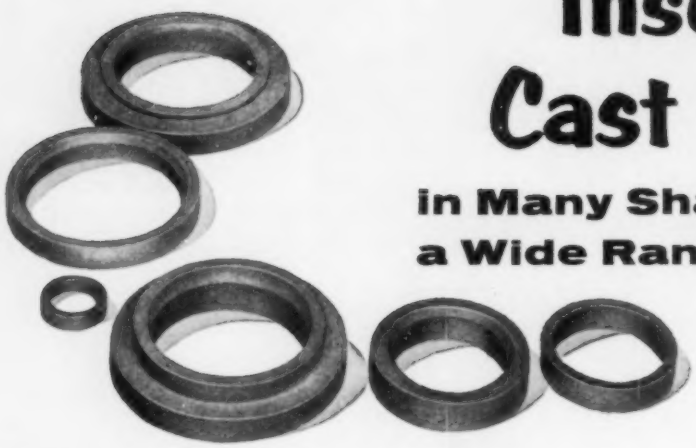
Largest Manufacturers of Electric Resistance Welding Machines in the World

SCIAKY

4913 West 67th Street, Chicago 38, Illinois

Inserts of Cast Eatonite

in Many Shapes and Sizes for a Wide Range of Applications



Resistant to—

- Corrosion
- Abrasion and scuffing
- Distortion, shock
- Cracking under cycling temperatures
- Acids, salt water

Non-magnetic, Non-oxidizing
Excellent hot strength, hot hardness

Our metallurgical and engineering departments will welcome an opportunity to discuss recommendations for the application of Eatonite to your products.

EATON MANUFACTURING COMPANY
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...give positive control of multiple complex circuits!

The versatility of Ledex Relays makes it possible to produce special switching combinations for specific applications. Stepping or selective controls are available depending upon the requirements. A wide range of operating voltages can be used by selecting the proper Ledex coil wire size.

HERE'S HOW A LEDEX RELAY OPERATES . . .

A LEDEX ROTARY SOLENOID provides the mechanical power to drive the gang of rotary, wafer type switches. SELECTIVE CONTROL —The commutating switch of the Ledex in combination with the control wafer switch makes it possible to select the multiple circuits to be connected by a single manually operated switch. RATCHETS are used to transmit the oscillating action of the Rotary Solenoid to the Relay rotor shaft. CIRCUIT WAFERS are produced in combinations of 8, 10, 12, 18 and 24 positions. All wafer sections are versatile in application. For example the 12 position wafer switch may be designed to utilize almost any of the factors of 12 such as 1P-12T, 2P-6T, 3P-4T, or 4P-3T. The clips and rotors of the wafer switches are of silver alloy. For most applications the switch insulation is of wax-impregnated bakelite. Ledex Relays are available with foot, flange or panel mountings.

The Engineering staff of G. H. Leland, Inc., will assist you in developing solenoid operated Relays best suited to your products!

WRITE FOR DESCRIPTIVE LITERATURE TODAY!

G. H. LELAND, INC.
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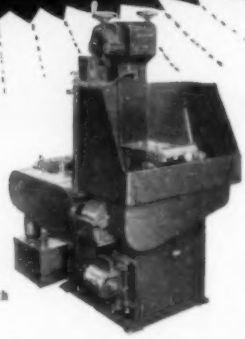
STARTS INSTANTANEOUSLY!

THE RUTHMAN GUSHER COOLANT PUMP



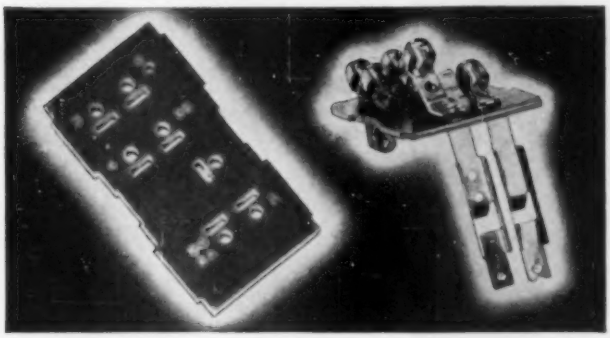
Illustrated is a Hammond 8" Model V-8WP Wet and Dry Abrasive Belt Grinder equipped with a Gusher Coolant pump.

With a Ruthman Gusher Coolant Pump you get plenty of coolant when you want it, *the instant the machine is turned on.* There is no priming necessary, Gusher Coolant pumps are always ready to go to work. Pre-lubricated heavy-duty ball bearings, electronically balanced rotating assembly, with no metal-to-metal contact within the pump, assure you of less maintenance care, longer life. Send for our illustrated catalog today.

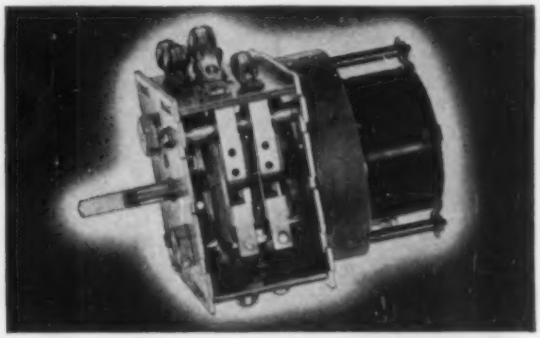
THE RUTHMAN MACHINERY CO.
1818 Reading Road Cincinnati, Ohio

What makes the miracle of automatic washdays? What gadget turns water on and off; starts spinners, agitators, fans; regulates heat . . . all on a precise timing schedule? Chances are it's a P. R. Mallory timer switch.

Special paper-base Dilecto laminated phenolic cams are the heart of the switch. If the corners are not sharp, if tolerances are not held, if the laminated plastic fails, the timing schedule would go haywire. But it doesn't happen with Dilecto cams *fabricated by C-D-F*, now definitely identified for performance comparison.



C-D-F also supplies these Dilecto insulating side boards. Dilecto Grade X-13 was chosen for its ability to withstand severe riveting and staking impact, for its sturdiness in holding up under the strain of plugs being inserted and removed from terminals mounted on the board.



Look inside the smart, small, tough Mallory timer switch. The shaft revolves; with the switch operated by a manual clock which is wound or set whenever the switch is turned over to complete the entire cycle. *Switch accuracy depends entirely on the degree of accuracy in which the cam is manufactured.*

C-D-F and DILECTO® LAMINATED PLASTIC helped Mallory

improve design . . . simplify purchasing . . . speed production

Two C-D-F Dilecto laminated plastic parts play small but vital roles inside P. R. Mallory's timer switches used to control the washing, drying, rinsing cycles.

Most important, the timing cams must be precisely fabricated to odd, notched shapes, with very close dimensional tolerances. In the design stage, it was first thought that there was no practical way to obtain the desired pieces.

But engineering-supplier teamwork always pays off. Good basic design . . . a quality material from an alert, interested fabricator . . . selective purchasing resulted in a solution.

C-D-F WORKS WITH DESIGNERS

A father and son team, in Mallory's Switch Division, Arthur and Harry Hall, began 15 years ago to make this timer switch. Cam material after material was tested . . . none worked satisfactorily.

C-D-F sales engineer Robert Tappan was called in. He says, "After 18 months, the design was adaptable to Dilecto laminated plastic. The first cam did not work, but showed promise. Looking back, it was a crude punching compared to the ones now furnished by the C-D-F Valparaiso plant."

A BIG, RELIABLE SOURCE

Mallory makes thousands of timer switches, naturally has several suppliers for laminated plastic insulation. But C-D-F keeps working hard to further improve the product: Special tools have been designed to increase the accuracy of C-D-F cams, to provide Mallory with *lower rejection* rates. Resin-penetrating and laminating techniques have improved Dilecto grades. Inspection and quality control have been modernized.

When you have a problem in laminated plastics, think of improved Dilecto and C-D-F. Send us your print for technical advice and quotation. Write for free test samples. The C-D-F catalog is in Sweet's Design File and the IRE Directory. Best of all, call your C-D-F sales engineer . . . He's a good man to know!

CDF *Continental-Diamond Fibre*

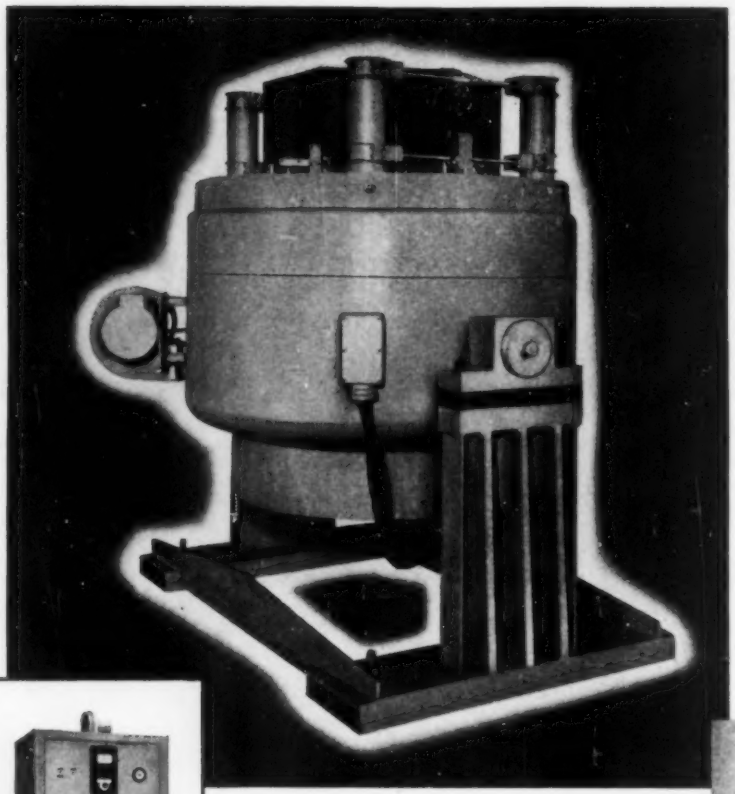
CONTINENTAL-DIAMOND FIBRE COMPANY

NEWARK 41, DELAWARE

Largest Vibration Exciter Ever Built

▶ *New MB shaker delivers 10,000 pounds force output!*

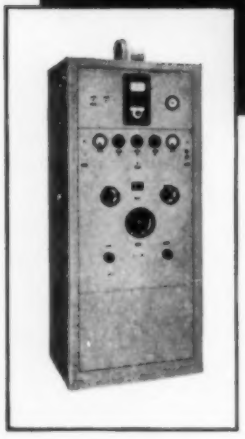
▶ *Widens scope of vibration testing to MIL-E-5272 and other specifications!*



HERE's the latest—and the *largest* – vibration exciter ever built for shake testing. Developed by MB vibration specialists, this unit incorporates all the advances made in the last seven years for assuring dependable operation, pure table motion, and absence of resonances. These include specially designed table flexures, forced air cooling, built in protection against overtravel of the table and against misoperation of the equipment.

This extra heavy duty, conservatively rated, electromagnetic shaker has the capacity and endurance to permit continuous testing at rated output. It will handle anything from electrical components to air-frame structures.

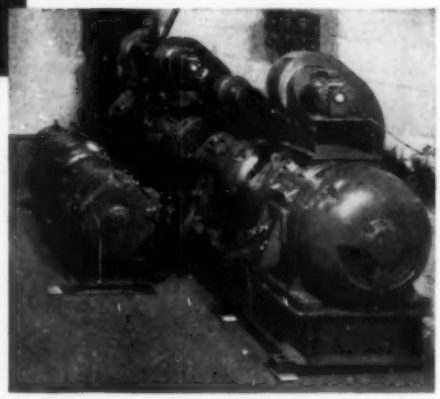
Remember—available MB Vibration Exciters now range from 5 pounds output size all the way up to this new giant. Make MB your headquarters for help on vibration testing and other problems.



MODEL C-100 VIBRATION EXCITER has ½" total table travel. Flexure design supports heavy table loads without sacrificing stroke. Trunnion support permits operation in all positions from horizontal to vertical, and has built-in vibration isolation. Operating range: 5 to 500 cps.

CONTROL PANEL (Model T-100) assures proper operation of equipment with interlocked controls. Accurate, easy, continuous control of force and frequency permits quick adjustments, or "scanning" over entire operating range. MB Vibration Meter provided; also running time meter.

ROTATING POWER SUPPLY rated to deliver full power without need for power factor correction. Blowers cool each unit separately. Alternators feed driver coil of shaker, with minimum harmonic distortion.



THE MB MANUFACTURING COMPANY, INC.
1060 STATE STREET, NEW HAVEN 11, CONN.

BULLETIN TELLS MORE
Contains specifications, operating information and helpful hints on usages of the complete line of MB Exciters. Write for Bulletin 1-VE-6.

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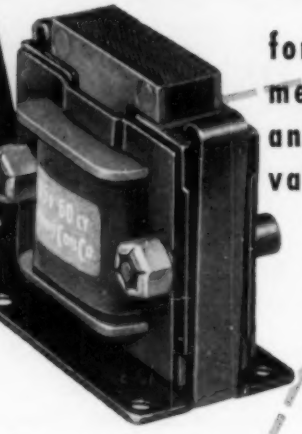

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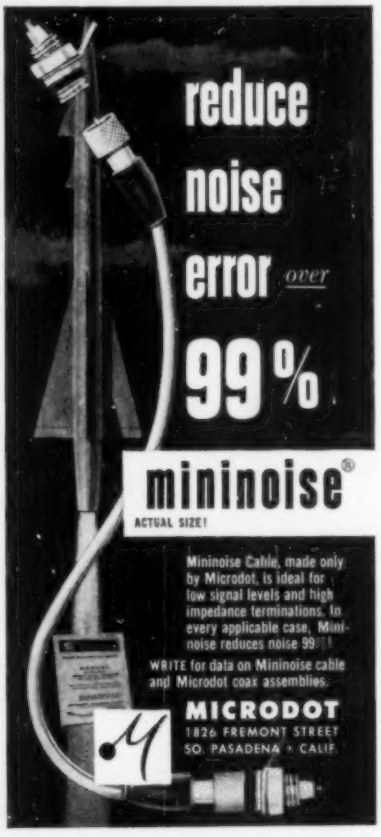
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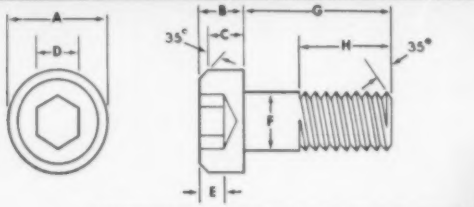

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MATERIAL SAE 4140 STEEL ALLOY- ROCKWELL							
FINISH CHROMIUM PLATING ON STEEL G.M. 4251-							
TOLERANCE IN LENGTH THE TOLERANCE IN LENGTH							
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Mac-it socket-head screws, providing strength without bulk, give lighter weight, streamlining, and more secure fastening to equipment you design. Whether the design problem involves standard or special screws, Mac-it will add to the appearance, efficiency and performance of the equipment. Use Mac-it Fastener Engineering Service for all problems involving screws for any type application.

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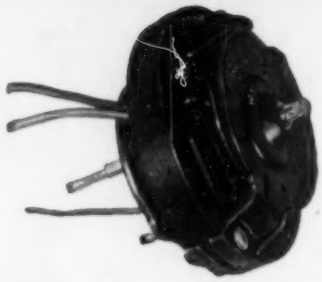
Manufactured by Mac-it Parts Co., Lancaster, Pa.

Contact your nearest Mac-it distributor or the Home Office, Cleveland, Ohio, for the Mac-it Catalog No. 49 which contains full technical data.

HEINZE MOTORS



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1/100 hp, 2-pole. Operates at free speed of 3300 rpm or load speed of 3100 rpm.

40 watts, 24 volts, 60 cycles, AC.

Skeleton frame, but can be supplied in ventilated case, same size and appearance as Heinze Type Z motor.

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The Heinze catalog shows this and other Heinze sub-fractional horsepower motors and blowers.

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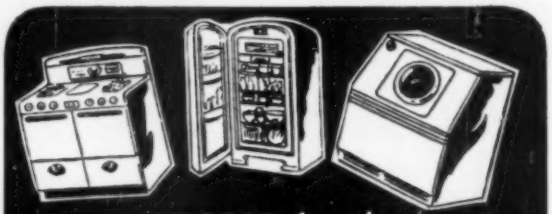

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CONTACT RATING: 22A. 230/115V.
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For full information write for Folder #359.

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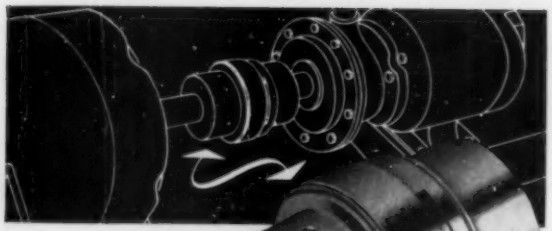
Wilcolator (Canada) Ltd., Mimico, Toronto, Ont.



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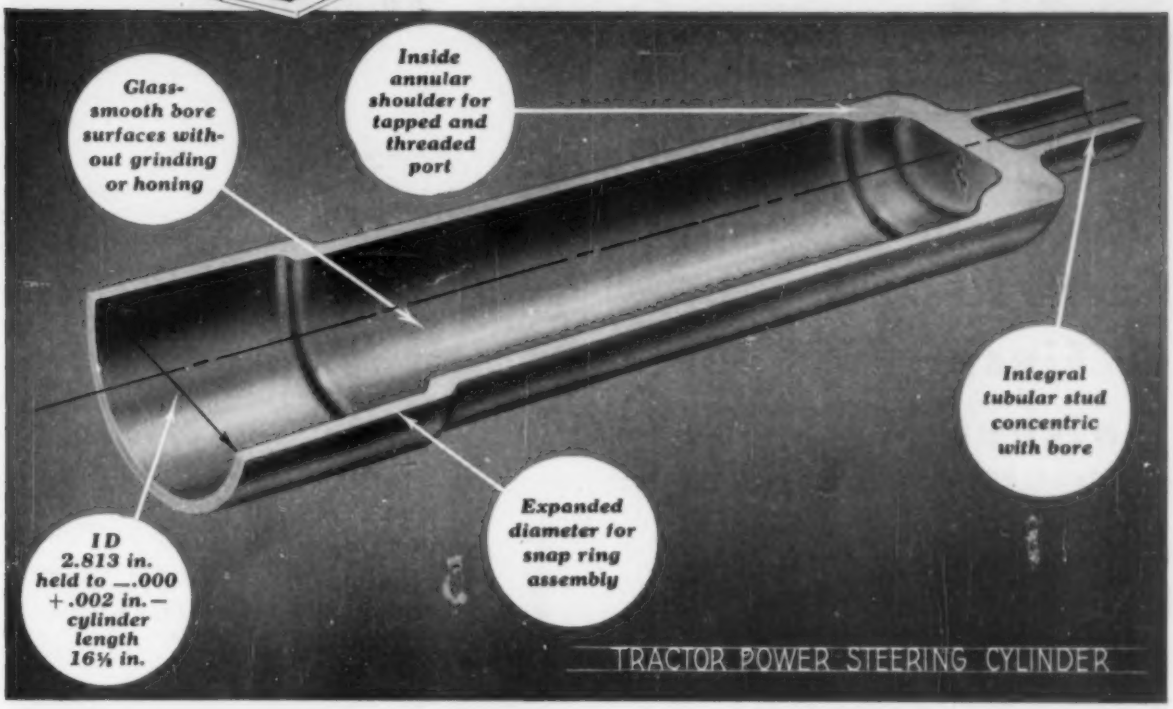
*Now **Mullins Koldflo** makes your dream design **practical***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High quality special features at low cost — and . . .

Mullins *Koldflo* extrudes this finished part in one piece . . . *without machining*

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Salem, Ohio

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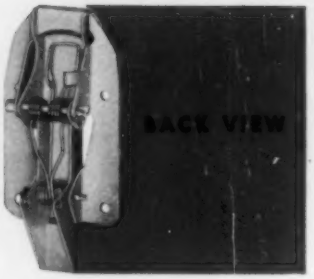
FRONT VIEW

SIDE VIEW



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300 COMBINATIONS OF DOOR AND FRAME THICKNESSES

HARTWELL Trigger-action Flush Latches are produced in over 300 standard combinations of bolt and trigger offsets. We can supply a latch for any door to be latched in any frame within thickness ranges common to standard sheet metal practice.

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New 1954 Catalog illustrates and gives full details of complete line.

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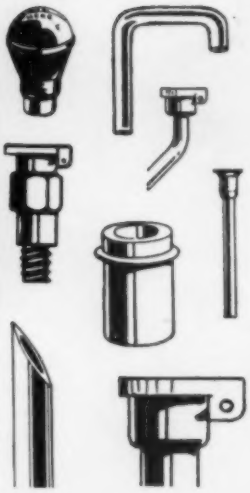
Our facilities for both high volume and small quantity runs of special tube forms are at your disposal. We shall be pleased to quote, submit samples or aid in design of any oiling devices or special formed tube parts, the following being a few of the many tube parts we can make:



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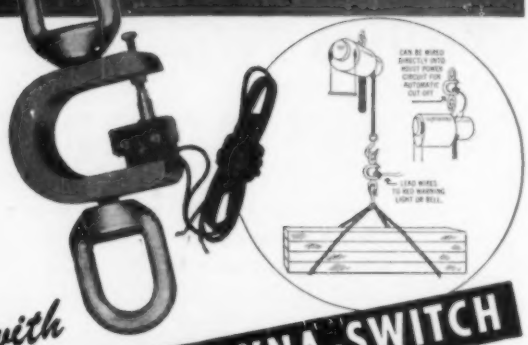
Prevent Overloading HOISTS & CRANES



with DILLON DYNA-SWITCH

When load limit is exceeded, Dyna-Switch trips a sensitive micro-switch which may be connected to a warning bell or light. If Dyna-Switch is connected into the motor, the overload automatically cuts motor out, and load must be returned to floor and surplus weight removed before pickup can be completed.

Top working range is 10,000 lbs. Set at factory for any desired cutout point, but can also be re-set in the field if working conditions change. Low in cost—always on guard. Write or wire today for illustrated bulletin.

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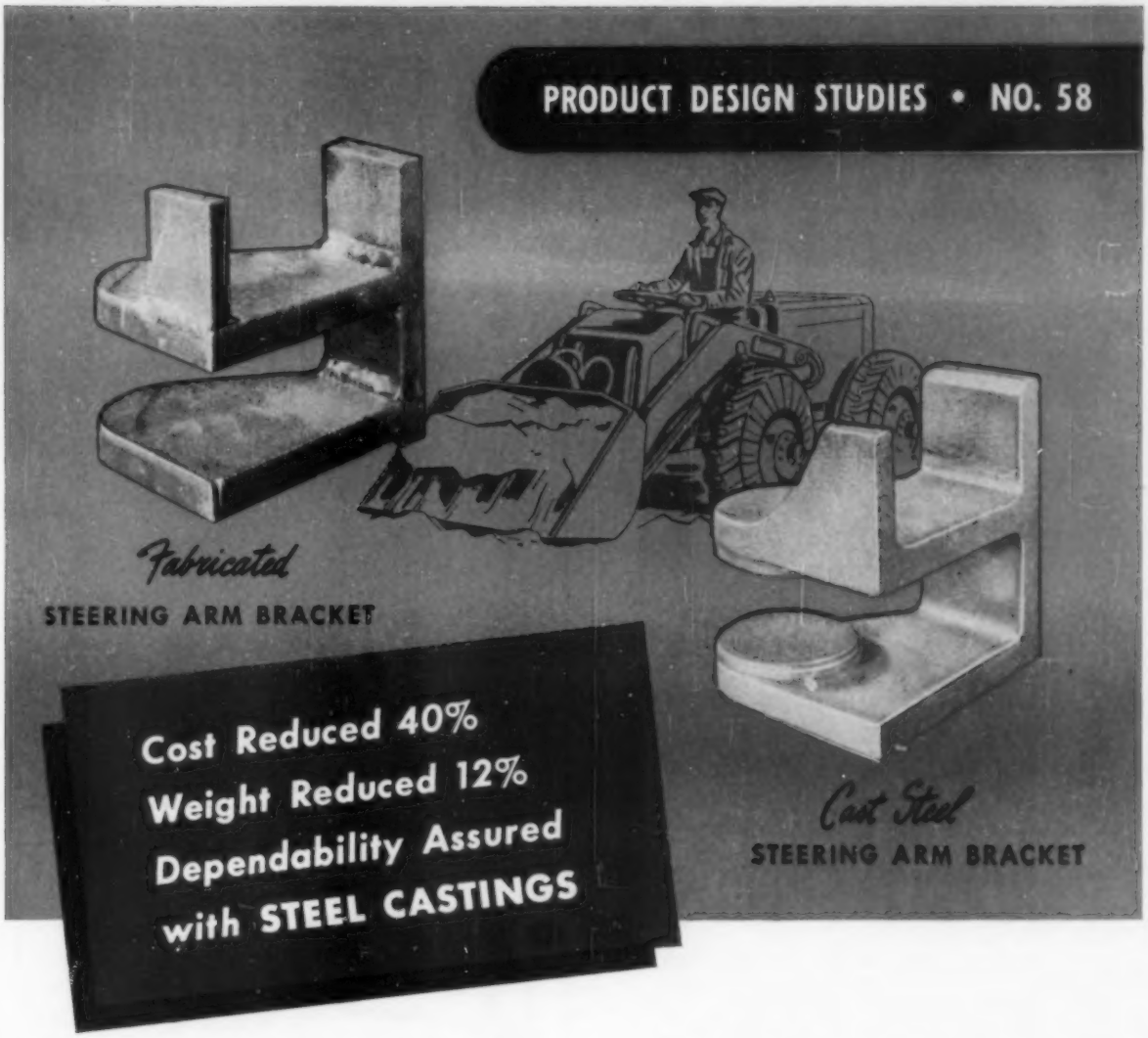

This is a steering arm bracket for a tractor-shovel front end loader. Originally produced as a weldment, the part was redesigned to a *foundry engineered* steel casting, effecting a reduction in cost of 40% and a reduction in weight of 12%.

Good casting design, resulting from cooperation of manufacturer's engineering department and the steel foundry, does four things (1) insures full use of the inherent properties of the metal (2) provides economy in manufacturing (3) produces a part which gives good service (4) improves appearance.

* * *

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Product Development Contest...

Two awards of $1000 each and four other cash awards—a total of $3500. Entries to be new ideas or applications of steel castings, and case histories of new jobs put into production. Write for folder giving full information.

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New 16-page booklet

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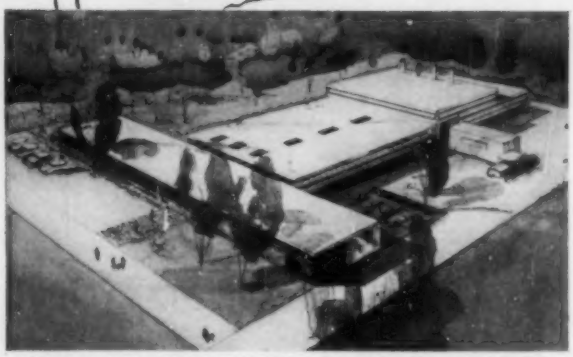

FERROUS AND NON-FERROUS PRECISION CASTINGS

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TOP VALUE

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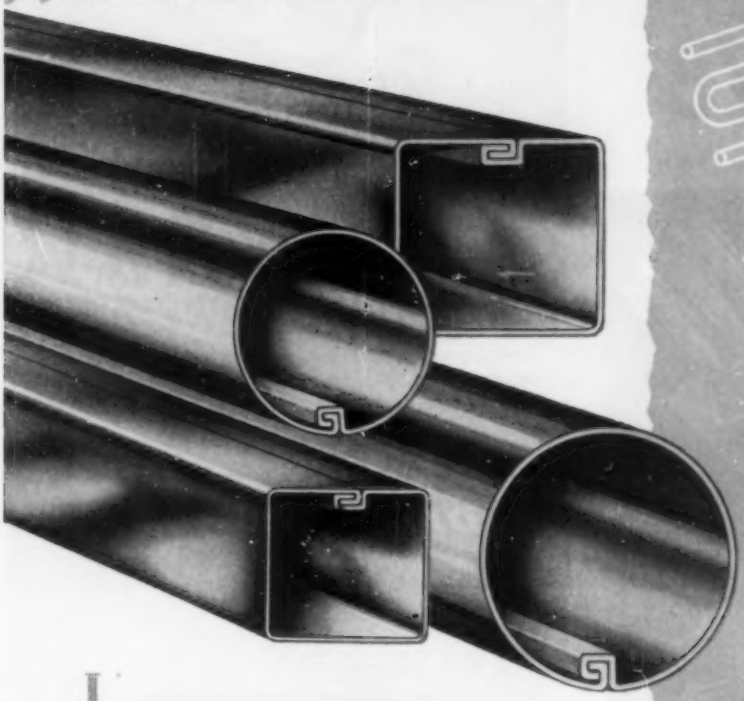
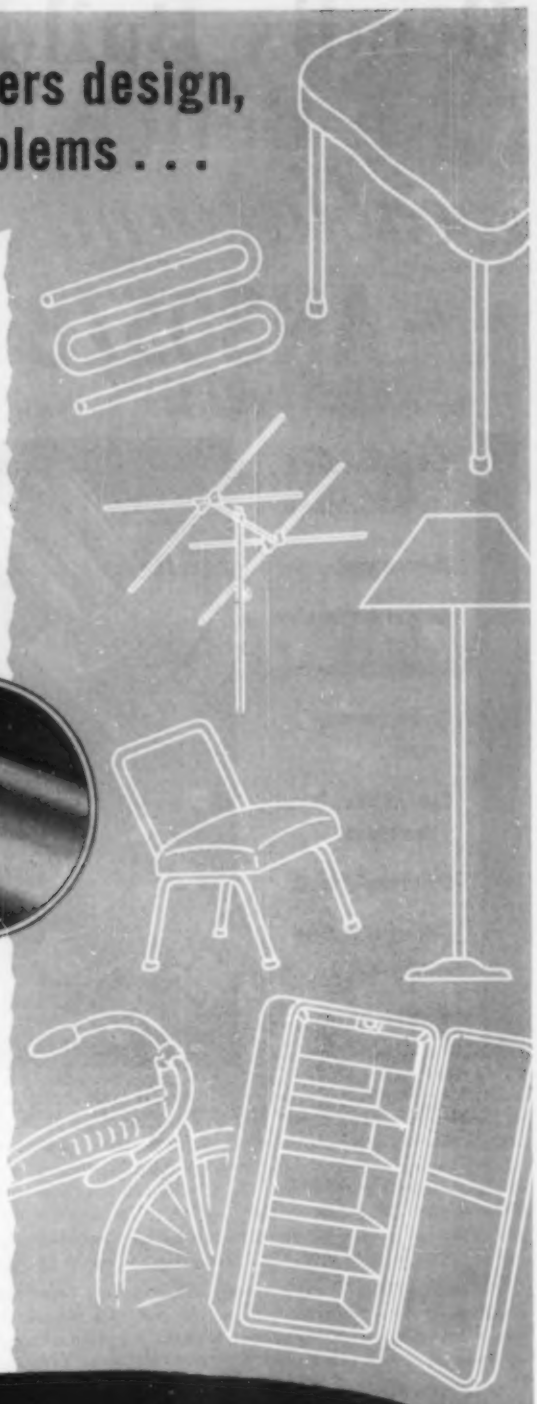
METAL PLAN FILE

MAYLINE

Roll Formed Tubing answers design, production and cost problems . . .





Less expensive Roll Formed Lockseam Tubing cuts costs on all tubing jobs. In many cases it does a better job than more expensive tubing. Lockseam Tubing can be bent as easily as other types. Your tubing is delivered ready for use. Send us your blueprints for steel or aluminum Lockseam Tubing. Let us prove that Roll Formed can help you produce a better product at less cost. For complete details on Roll Formed tubing and special shapes write for Catalog 1053. It tells the complete Roll Formed story.

ROUND SIZES — LOCKSEAM TUBING

Section No.	Wall Thickness	O.D.	Section No.	Wall Thickness	O.D.
2172	.018	½"	2096	.025—.030—.035	1"
2173	.018	⅝"	2020	.025	1⅛"
2103	.025—.030	¾"	2030	.030—.035—.040	1¼"
2174	.025—.028—.032	⅞"	2176	.030	1½"

ROLL FORMED PRODUCTS COMPANY

MAIN OFFICE AND PLANT
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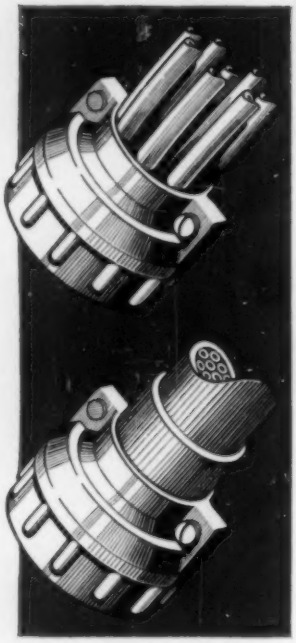
Bendix Builds a Better *cable clamp* the AN3057B

Inexpensive Efficient Versatile

Outstanding Features

- Neoprene gland.
- Centered clamping action.
- Increased close down.
- Positive grounding feature.
- Cadmium plated die-cast aluminum nut.
- Shorter over-all length.
- Waterproofs multi-conductor cable.
- Immediate delivery.



The new Bendix AN approved AN3057B cable clamp is now available. Engineered by Bendix to the highest quality standards, this cable clamp offers major design improvements. The clamping action is radial and completely eliminates wire strain and chafing by holding the wire bundle firmly in rubber. This clamp will accommodate a wide range of wire bundle sizes, but an even greater range can be handled through the use of the Bendix AN3420A accessory telescoping sleeve.

The new AN3057B cable clamp will also waterproof multi-conductor rubber covered cable on the rear of a connector, or where moisture-proof entrance through a bulkhead or into an equipment box is required.

This versatile clamp is a product of the Scintilla Magneto Division of Bendix Aviation Corporation and is a companion AN accessory to the world famous Bendix Scinflex line of electrical connectors. Write our Sales Department for details.

Bendix

SCINTILLA DIVISION of Bendix Aviation Corporation SIDNEY, NEW YORK

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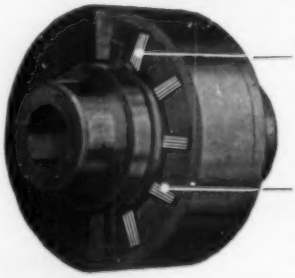
HERE'S WHY

KUSHION-TORQ

LENGTHENS EQUIPMENT LIFE



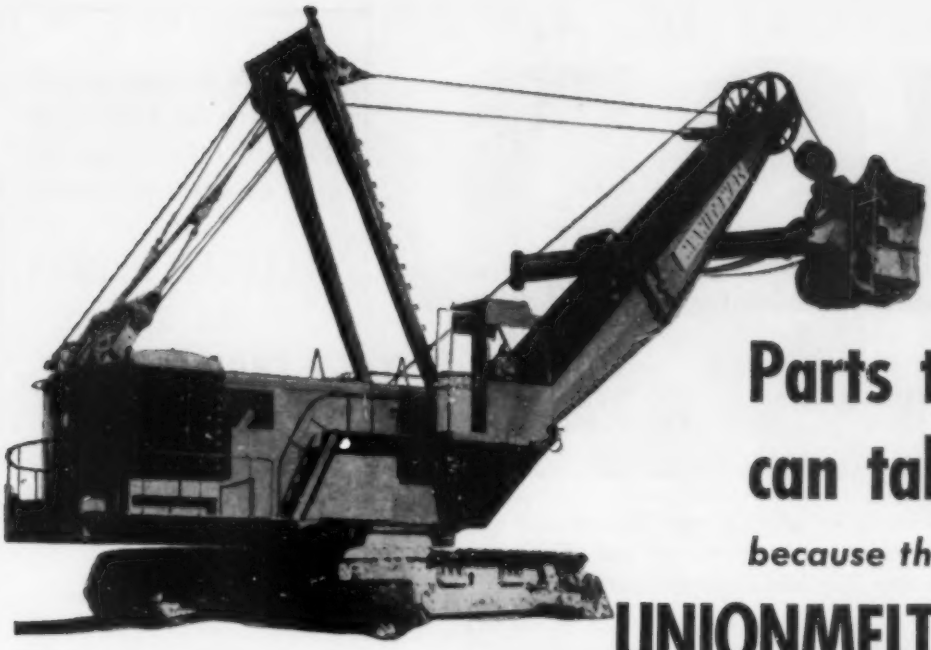
Laminated Kantilever Steel Springs transmit driving action.

Tapered slots move point of driving contact inward as loads increase to automatically stiffen kantilevers.

These Brown Coupling features mean equipment is shock and load protected - - - coupling failure is reduced - - - misalignment is corrected - - - radial and torsional vibration are dampened - - - both drive and driven units last longer.

For complete information shown in Bulletin 28P, write Brown Engineering Co., 108 N. 3rd St., Reading, Pa.

BROWN KUSHION-TORQ COUPLINGS



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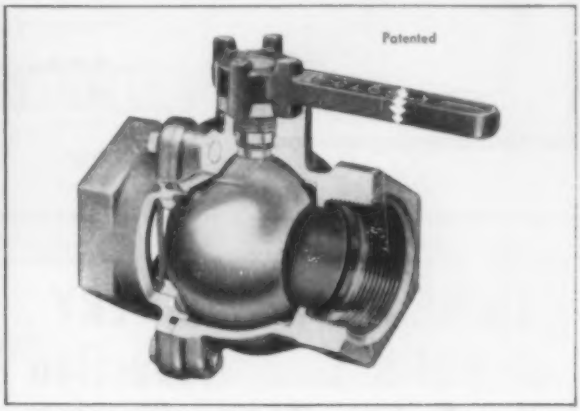

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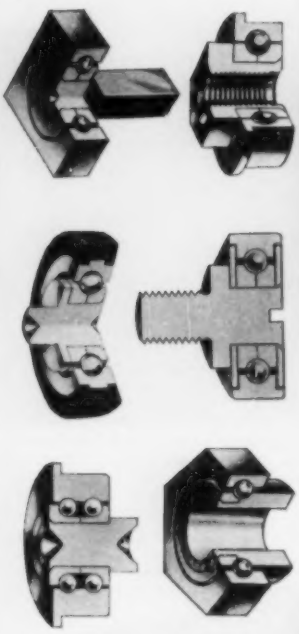

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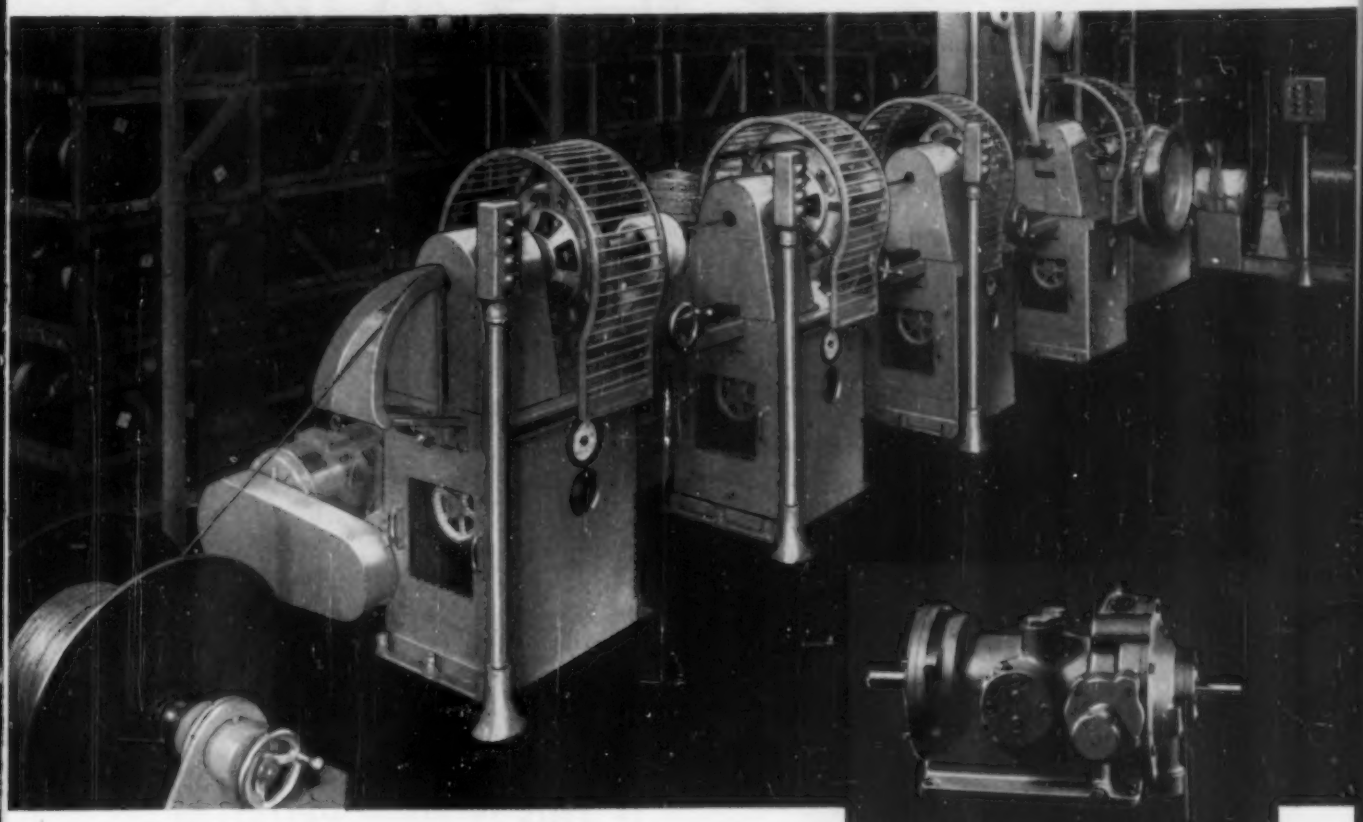

Its use of Oilgear Fluid Power

Western Electric Company, manufacturing unit of the Bell Telephone System, originates, designs and builds many of the special machines it uses in its own manufacturing processes. It also maintains unceasing pressure to improve upon machines already in operation, for optimum performance, for better product, for lower costs, for freedom from trouble.

Its use of Oilgear Fluid Power Drives and Transmissions has been increasing because, in the words of their engineers, Oilgear enables them among other things to synchronize many machine components easily and economically. A good example of all these points is the "short haul" video cable wrapping machine pictured above.

This machine was designed and built by the company's own men some years ago. For optimum performance, the speed of the heads should be easily and independently variable and the direction of rotation instantly changeable because the lay and pitch of the wrappings must be varied according to the requirements of the run. Moreover, the inside contour of the tube formed by the wrapping should be smooth and uniform so as to avoid setting up echo waves that interfere with transmission and vitiate signal strength.

Because of these requirements, a new drive was installed something over 4 years ago. A line shaft drives five Oilgear Fluid Power Transmissions, one at each machine head and the capstan.

The results were these: uniformity and control of tension are so good, the machine runs at 4 times its former machine speed; it is easy to vary speed and direction of rotation of each individual head; eccentric heads gave way to concentric heads, and supply spools are now loaded to full capacity instead of ¼th to ⅛th as before; the machine is stopped less frequently for loading. Maintenance on the former drive was involved and frequent—on the Oilgear equipment it has been simple and negligible.

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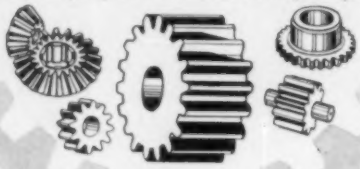

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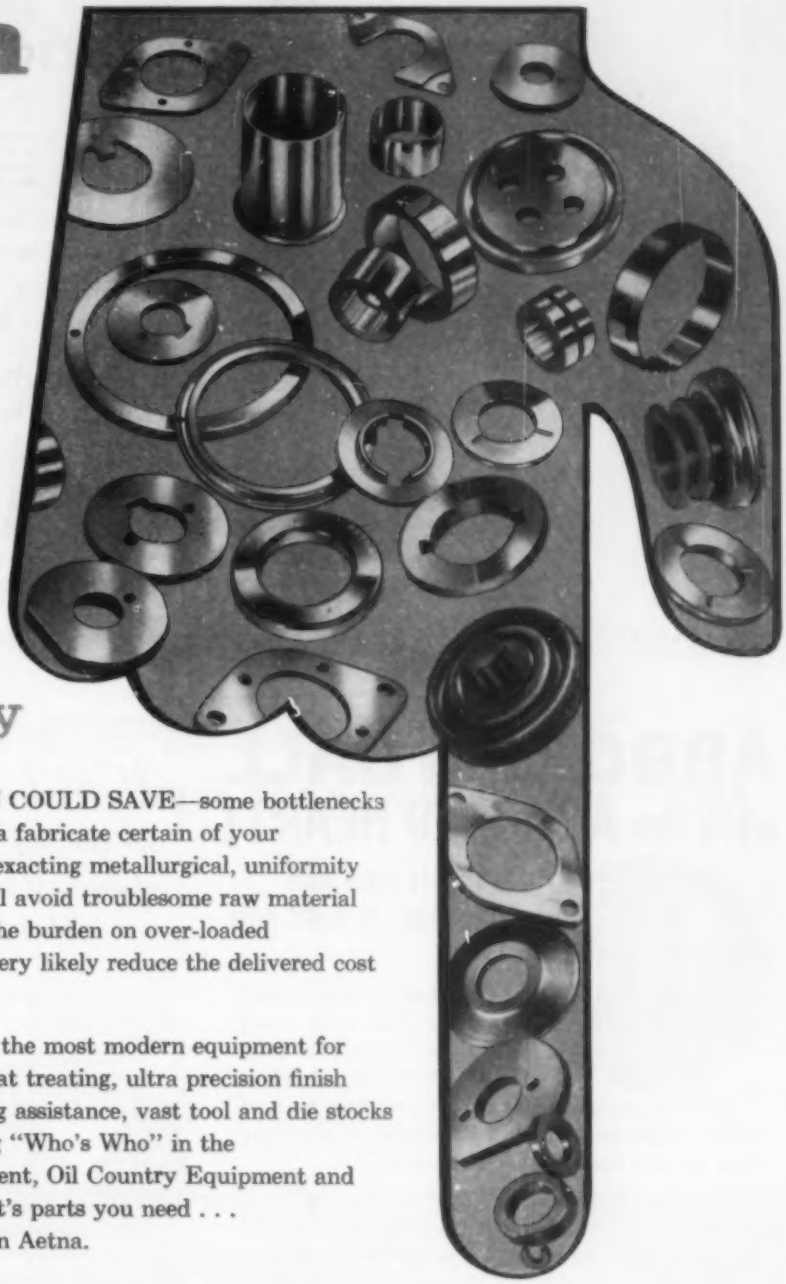

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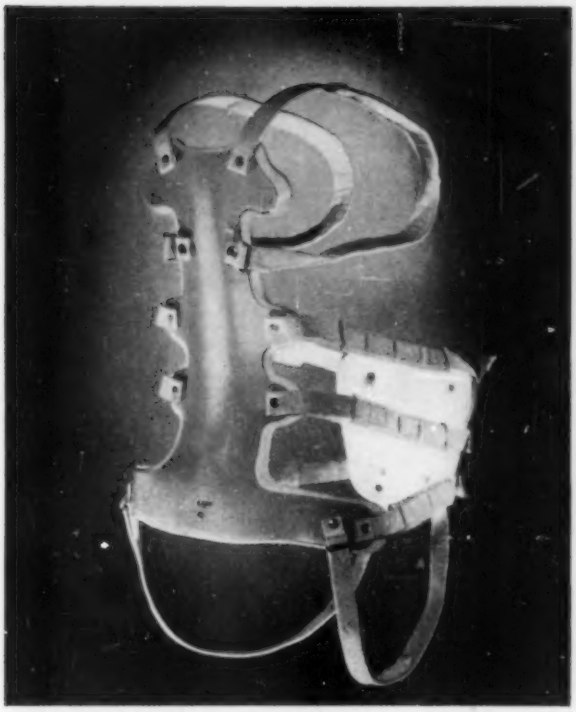

Warmed by an infra-red lamp, this back brace softens so that the doctor can shape it to fit the patient exactly. Forming takes only a few minutes compared to several days needed with earlier materials. Other features are strength, washability, light weight, coolness. Precise fit makes it less conspicuous when worn. Made by **S. H. Camp & Company,** Jackson, Mich.

Fish flies are always visible through the transparent sides of this case, making selection easy. Its open face and holes in its sides help flies to dry fast. Tough and resilient, it protects flies from other gear in tackle box. Magnets in base hold hooks under all conditions. Pinning to pocket flap keeps it within easy reach. Data courtesy **Plasti-Print, Inc.,** Royal Oak, Mich.

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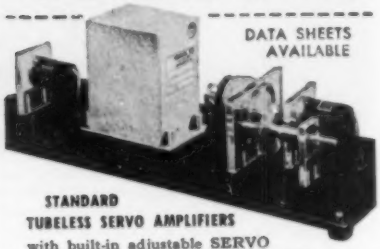

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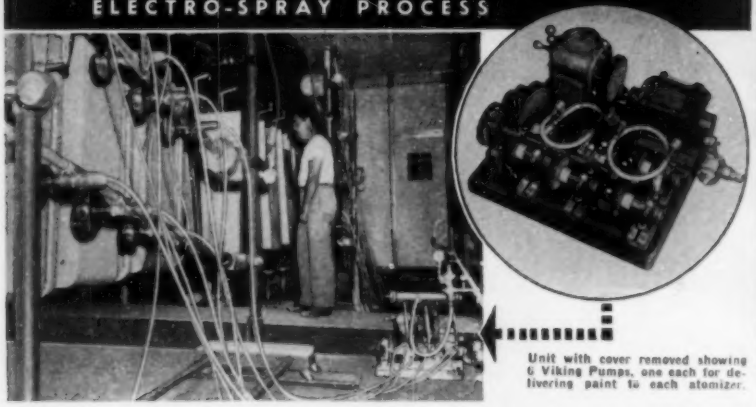

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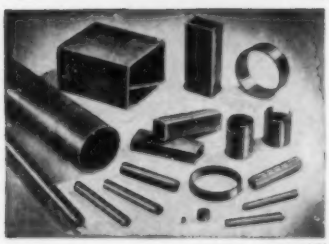

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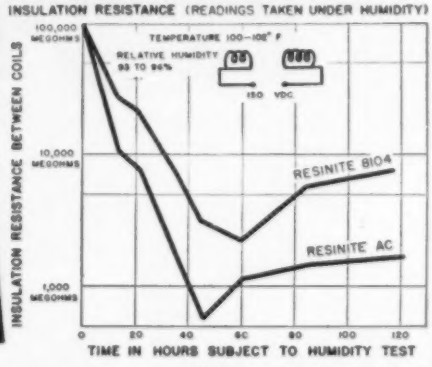

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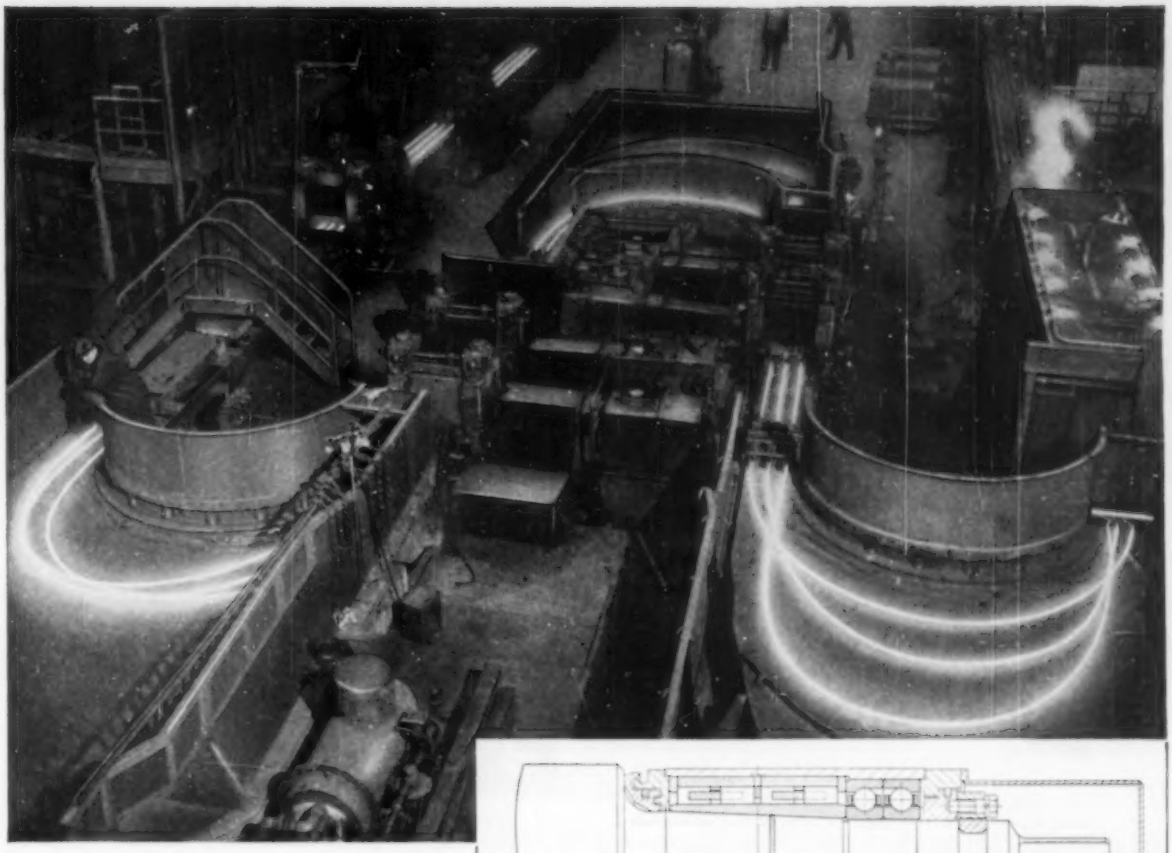
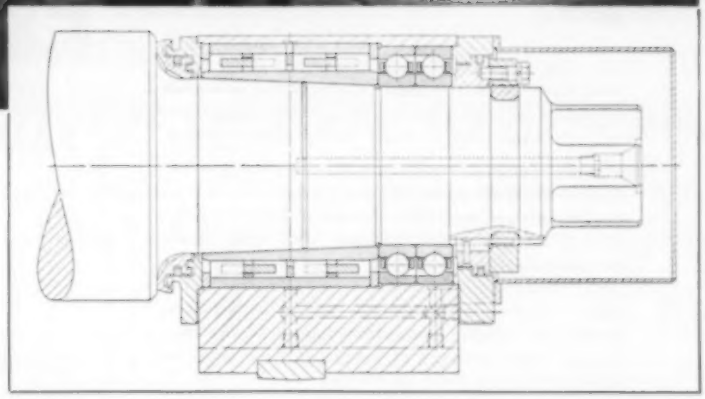


top quality rod
at better than
50 miles per hour



SKF Roll Neck as installed in United's Rendleman Mill at Jones & Laughlin. Dotted lines show oil passages for quick, easy bearing removal by the SKF-pioneered Hydraulic Removal System.

SKF multi-row cylindrical bearings installed on the roll necks of the Jones & Laughlin Rendleman rod mill by United Engineering and Foundry Company, are doing an outstanding job at mill speeds of 4700 feet per minute.

The SKF multi-row cylindrical bearing was specifically designed for roll neck applications. This four row grease lubricated bearing incorporates all those necessary qualities for the highest standards of roll neck bearing performance long desired by mill builders.

This is another example of SKF leadership in the rolling mill field. Consult SKF and have *them* help *you* "put the right bearing in the right place."

SKF INDUSTRIES, INC., Philadelphia 32, Pa.—*manufacturers of* **SKF** *and* HESS-BRIGHT® *bearings.*

7401

SKF®
BALL AND ROLLER BEARINGS

REPLACEMENTS ALWAYS FIT EXACTLY WHEN YOU USE

Bond® STOCK GEARS

From the machine owner's viewpoint, Bond Stock Gears have two advantages: (1) replacements always fit exactly; and (2) ordering by symbols saves time and eliminates risk of order being misinterpreted.

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From any viewpoint, you benefit by using Bond Stock Gears on every machine you design and build. The complete line is listed in Bond Catalog No. 65. Write for your copy today.

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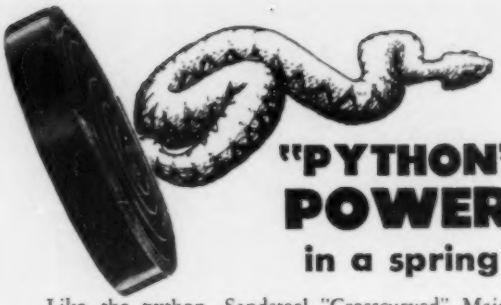
SPEED REDUCERS



"PYTHON" POWER in a spring

Like the python, Sandsteel "Crosscurved" Mainsprings contain a vast reserve of power which can be released evenly. And, with an eye to design, they are engineered to deliver maximum power from the smallest spring—made possible by the special Sandsteel "Crosscurving" process. "Crosscurving" demands high-quality steel; and the finest Swedish steel is used in the construction of Sandsteel "Crosscurved" Mainsprings. They are designed to meet specific engineering needs and provide long life and excellent performance in the product.

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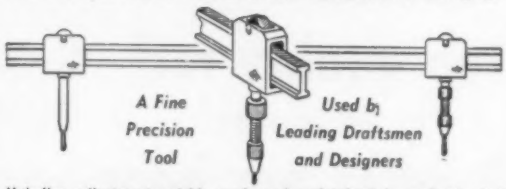
SANDVIK STEEL, Inc.
145 HUDSON STREET, NEW YORK 13, N. Y.

FAMOUS BEAM COMPASS



Hair-line adjustment quickly made and maintained by spring-loaded thumb rollers. No screws or clamps. Lead expeller for easy control of lead length. Slides instantly interchangeable to any beam length. Made of anodized aluminum, stainless satin finish. Beam lengths from 7" to 100". **WRITE FOR LITERATURE.**

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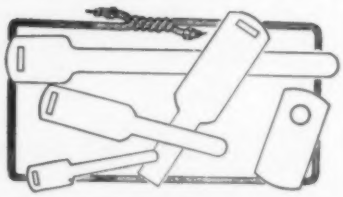

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Ketay

presents

••• meticulously tailored

MAGNETIC AMPLIFIER SERVO SYSTEMS

Typical characteristics of some magnetic amplifier and two-phase servo motor combinations available from Ketay.

SPECIFY MAGNETIC AMPLIFIER (type)	FREQUENCY (cps)	LINE VOLTAGE (volts)	LENGTH (inches)	WIDTH (inches)	HEIGHT (inches)	SPECIFY SERVO MOTOR (type)	TORQUE AT STALL (oz. in.)	MOMENT OF INERTIA (oz. in. x sec^2 x 10^4)	ACCELERATION AT STALL (rad./sec^2)	NO LOAD SPEED (min. r.p.m.)	RATED VOLTAGE EXCITATION FIXED PHASE (volts) *	INPUT POWER PER PHASE AT STALL (watts)	DIAMETER (inches)	LENGTH (inches)
SMA6-102	60	115	4 1/2	3 3/4	3 7/8	K402530	2.5	49.5	50,500	3300	115	9.2	1 3/4	2
SMA6-102	60	115	4 1/2	3 3/4	3 7/8	K402380	1.45	42.8	35,000	3200	115	5.0	1 7/16	1 5/8
SMA4-102	400	115	4 1/8	3 5/16	4 3/16	K402550-1	2.35	49.5	47,500	4800	115	9.2	1 3/4	2
SMA4-102	400	115	4 1/8	3 5/16	4 3/16	K402550-2	2.35	49.5	47,500	4800	115	9.2	1 3/4	2
SMA4-102	400	115	4 1/8	3 5/16	4 3/16	K101600-6	1.45	42.8	35,000	4800	115	6.1	1 7/16	1 5/8
SMA4-102	400	115	4 1/8	3 5/16	4 3/16	K101660	1.45	42.8	35,000	4800	115	6.1	1 7/16	1 5/8

BUORD DESIGNATIONS FOR SERVO MOTORS

K101600-6 = MK 7 MOD 0 K101660 = MK 7 MOD 1

K402550-2 = MK 8 MOD 1 K402550-1 = MK 8 MOD 0

* The control phase of all Servo Motors should be connected for 57.5 volt operation.

On the other side of this page are listed some of the synchros for which the combinations were specially designed.

Ketay supplies complete systems including gear trains and stabilization for given kinematic requirements.

Servo motor-tachometer generator combinations are also available.

Ketay welcomes the opportunity to design and fabricate amplifiers of both the conventional and miniaturized types to customer's specifications.

SYNCHROS • SERVO MOTORS
RESOLVERS • MAGNETIC AMPLIFIERS
AIRBORNE INSTRUMENTS
AUTOMATIC CONTROL SYSTEMS

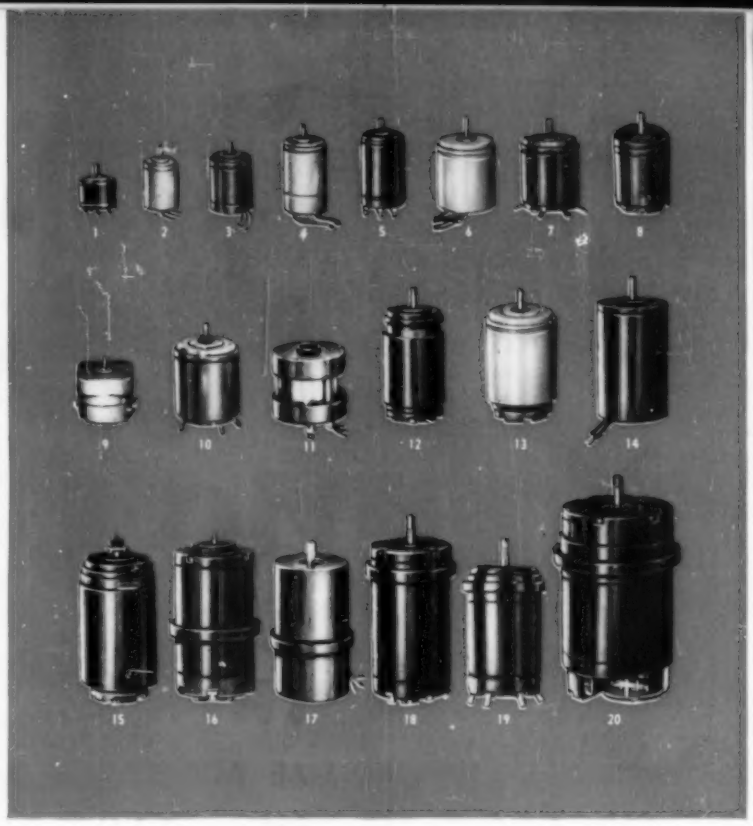
Ketay

MANUFACTURING CORP.
Executive Offices
555 Broadway, New York 12, N. Y.

KETAY OFFERS A COMPLETE RANGE OF SIZES AND TYPES IN SYNCHROS • SERVO MOTORS RESOLVERS

1–SERVO MOTOR, Size 10 Frame, O.D. .937"
2–SYNCHRO, Size 10 Frame, O.D. .937" (Transmitter, Receiver, Resolver, Differential Transmitter, Control Transformer)
3–SERVO MOTOR, Size 10 Frame, O.D. .937"
4–SYNCHRO, Size 11 Frame, O.D. 1.062" (Transmitter, Resolver, Control Transformer)
5–SERVO MOTOR, Mk 14, Size 11 Frame, O.D. 1.062"
6–SYNCHRO, Size 15 Frame, O.D. 1.437" (Transmitter, Receiver, Resolver, Differential Transmitter, Control Transformer)
7–SERVO MOTOR Mk 7, Size 15 Frame, O.D. 1.437"
8–SYNCHRO, Size 15 Frame, O.D. 1.437" (Transmitter, Receiver, Resolver, Differential Transmitter, Control Transformer)
9–LINEAR TYPE CONTROL TRANSFORMER, O.D. 1.625"
10–SERVO MOTOR, Mk 8, Size 18 Frame, O.D. 1.75"
11–INDUCTION MOTOR, Size 20 Frame, O.D. 1.95"
12–SYNCHRO, Size 16 Frame, O.D. 1.537" (Transmitter, Receiver, Control Transformer)
13–SYNCHRO, Size 18 Frame, O.D. 1.750" (Transmitter, Receiver, Differential Transmitter, Control Transformer)
14–INDUCTION MOTOR, Size 18 Frame, O.D. 1.750", 3 Phase, 2 Pole
15–SYNCHRO, Size 19 Frame, O.D. 1.90" (Transmitter, Receiver, Control Transformer)
16–SYNCHRO, Type 1F, 1HCT, or 1HG Size 1 Frame, O.D. 2.250" (Receiver, Transmitter, Control Transformer)
17–INDUCTION MOTOR, Size 1 Frame, O.D. 2.250"
18–SYNCHRO, Size 23 Frame, O.D. 2.250" (Transmitter, Receiver, Resolver, Differential Transmitter, Control Transformer)
19–SERVO MOTOR, Size 23 Frame, O.D. 2.250"
20–SYNCHRO, Size 31 Frame, O.D. 3.10" (Transmitter, Receiver, Differential Receiver, Differential Transmitter)

Typical characteristics of 116 units are available.

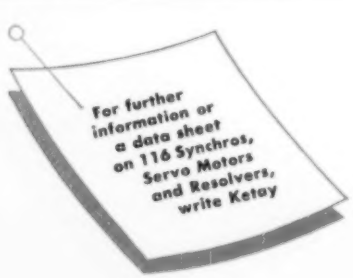


ADDITIONAL FACILITIES TO SERVE THE INDUSTRY

This plant, recently acquired at Commack, Long Island, adds air-conditioned work space that brings Ketay's total area to over 200,000 square feet, accommodating over 2,000 employees in the five divisions. Modern in every detail, the new plant has the latest equipment for precision volume production.

EXPERIENCE + RESEARCH + PERFORMANCE = LEADERSHIP

New developments and applications... increased facilities for volume production of components and complete systems... all the things reported on these pages are characteristic of Ketay— a firm with broad experience and specialized knowledge that adds up to leadership in the field of electrical devices and controls. This experience and knowledge is yours to command. In addition to synchros, servo motors and resolvers, it includes, but is not limited to: gyro components; aircraft engine instruments; computers; magnetic, resolver and synchro amplifiers; remote indicators and automatic control systems. Ketay's completely staffed and equipped Research and Development Division can be of greatest service during the design stage of applications involving Ketay products. You are invited to avail yourself of this service.



Ketay
MANUFACTURING CORP.

Executive Offices **555 Broadway, New York 12, N. Y.**
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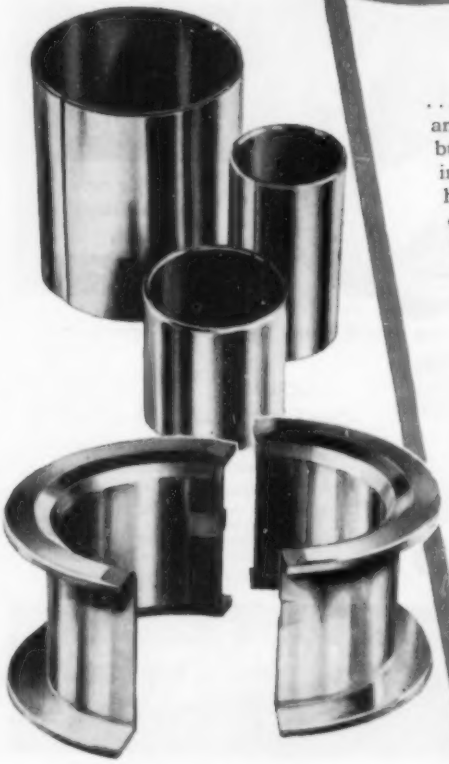
JOHNSON MODERNIZED SLEEVE BEARINGS

SOLVE MANY SPECIFIC PROBLEMS



The sleeve bearing is basic in principle . . . for most applications man's genius has never invented any device to replace it. For instance, every internal combustion engine is dependent on it, and the majority of industrial equipment is, too. But modern requirements, high speeds, higher loads, and changing designs have called for new sleeve bearings. Johnson Bronze, alert to the demands of new engineering trends, is producing Johnson Modernized Sleeve Bearings, capable of giving the utmost service under these modern conditions. Aluminum bonded to steel is one of them. Copper-lead bronze-on-steel is another. New materials, new combinations of materials and new designs are meeting many new requirements. If you have a specific sleeve bearing problem, perhaps a Johnson engineer can help you. Write for an appointment.

JOHNSON BRONZE COMPANY
508 South Mill Street, New Castle, Pa.

JOHNSON JB BEARINGS
Sleeve-Type

JOHNSON BRONZE PRODUCES ALL TYPES OF SLEEVE BEARINGS: ALUMINUM-ON-STEEL • CAST ALUMINUM ALLOY • BRONZE-ON-STEEL, copper lead • STEEL BACK, babbitt lined • BRONZE BACK, babbitt lined • CAST BRONZE, plain or graphited • SHEET BRONZE, plain or graphited • LEDALOYL powder metallurgy

Operator sands down pips and rough spots before paneling passes between Pittsburgh brushes shown under exhaust hood.

Modern way to dust walls and ceilings

In producing wall and ceiling panels at the Barclay Manufacturing Co., New York City, dust caused by routing simulated "mortar lines" settles on the panels. The panels must be "dusted"—the dust *completely* removed—before they can be bake-finished.

Brushes originally used had a short life span, wore unevenly, and did so poor a job that many baked panels had to be completely refinished to pass inspection. Since even a "fairly good" brush would not do, Barclay searched for the *perfect* brush—and chose Pittsburgh! Result: Better work and costly refinishing eliminated!

WRITE TODAY for your free copy of our new booklet that shows, through actual case histories, how Pittsburgh can help cut your brushing costs. Address: Pittsburgh Plate Glass Co., *Brush Division*, Dept. W-6, Baltimore 29, Md.

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BRUSHES • PAINTS • GLASS • CHEMICALS • PLASTICS • FIBER GLASS

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Be Nut Wise call on WEMPY for any size.

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. . . giving both radial and thrust capacity

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Shaft rotation at moderate speeds. Lubricated for extended operation. Only a quarter inch section height. For shafts from 7/16" to 1½".

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at sensationally low prices

These rugged steel wiring boxes are completely oil and water splash proof as well as dust proof. THEY COMPLY WITH ALL J.I.C. ELECTRICAL SPECIFICATIONS FOR JUNCTION BOXES. There are no screw holes in the cover or knockouts to admit oil. The neoprene rubber gasket on the cover provides a tight seal. The cover can be removed by loosening only one screw. Most sizes may be obtained with a removable panel plate for mounting terminal strips or other electrical equipment.

Ideal for Machine Tool Wiring—

Many purchasers now demand that the electrical wiring and controls for machine tools be enclosed in oil-tight boxes. When oil, chips or water get into the machinery electrical circuit, the resultant "down time" is costly. Hoffman J.I.C. wiring boxes help eliminate this trouble. Ford, General Motors and Chrysler are some of the users of these new junction boxes.

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Standard sizes are:

4" x 4" x 3"	10" x 8" x 4"
6" x 4" x 3"	12" x 10" x 5"
6" x 6" x 4"	14" x 12" x 6"
8" x 6" x 3½"	16" x 14" x 6"

Prices range from $2.75 to $9.95

HOFFMAN ENGINEERING CORP.
Manufacturers of Wiring Troughs and N.E.M.A. 12 Panels
ANOKA, MINNESOTA

CORNING GLASS BULLETIN

FOR PRODUCT DESIGNERS

Tricky welding problem solved. Sometimes you back into a problem. For instance, heat generated by welding instrument panels into place was raising havoc in a plant where they assemble flying machines.

Glass windows used in the panels had to be mounted *before* the welding trick, but invariably they broke under the high temperatures the welding generated. Racking his brains for a solution to this vexing problem, someone thought of trying one of the VYCOR brand glasses. It worked. Now welders weld away to their heart's content without thought of setbacks from breaking glass.

A piece of VYCOR brand glass takes the heat from a blowtorch on one side and a cold water spray on the other without cracking or melting.

The ability of VYCOR brand 96% silica glass to stand up under remarkably wide variations in temperature—from below freezing to 1800° F.—makes it an exceptionally useful material. Our technical men attribute this ability to what they call "special thermal properties." We think you'll get some idea of just how much of this "thermal" stuff it's got from the picture above.

▶ An interesting piece entitled, *"Glass that laughs at heat"* tells a lot more about this fascinating material. We will be glad to send you a copy.

Glass that clicks because it doesn't. Elusive mercury (the only metal that flows at room temperature) helps take the click out of some electric wall switches.

But, it's a PYREX bulb no bigger than an unshelled peanut that keeps the mercury in line. Result—silent light from switches that don't click when you flick.

In all honesty we must admit we don't make this ingenious little bulb. What we *do* supply is the PYREX tubing to make the bulb that makes the silent switch.

How come *glass* for this tough but delicate service? Well, first of all, mercury being corrosive (as well as elusive) unites with most materials —but *not* with nonporous glass. Then, there's the little matter of insulation, not to be overlooked when directing traffic through electrical circuits. And, to frost the cake, glass (as you've probably found out) is often made so you can see through it. See-through-ability in this case makes inspection of the finished product quick and sure. And finally, glass can be joined to metal.

The glass used in the silent mercury switch is made from one of the more than 50,000 glass formulas on tap at Corning. Each formula has been developed in the search for just the right balance of mechanical, chemical, thermal, and/or electrical properties to satisfy some specific design or use problem. Maybe one of them can serve you.

▶ Any time you'd like to get a little deeper into the myriad uses to which product designers and engineers are putting glass, we'd be glad to aid your cause. The profusely illustrated booklet, *"GLASS and You"* gives a comprehensive picture of glass at work and play. Drop us a line and we'll whisk your copy on its way.

How to obsolete an elephant. When billiard balls aren't made of elephant ivory, chances are they're made of plastic.

After searching for a better molding material, a couple of billiard ball makers are now using glass with quite some success. Taking their cue from these game firms, others have also found glass molds useful in making plastic products with a minimum of fuss—precision items such as insulators for the radio and TV industry, and catheters to aid the cause of medicine are examples.

What's really important isn't so much what's being made in glass molds, as what has been proved about them. For one thing, because glass is nonadhesive, the plastic material doesn't stick to the mold—nor the mold to the plastic material. And when they're made in large enough quantities, glass molds are inexpensive enough to be expendable—just crack 'em off and throw 'em away when the plastic is set.

Sketch showing how billiard balls are molded in glass. When the plastic is set and cured, glass mold is simply cracked off and ball is ready to finish.

Glass molds can cut processing cost, too. Since products come out so smooth, they require less finishing. You can even hasten curing time by using dielectric heat.

▶ If plastic molding is on your mind, maybe you'll want to learn more about putting glass to work. Why not tell us what you have to mold and see if we can supply the answer.

If the items discussed here seem unrelated to your problem, we still may have what you need at our fingertips. We'd count it a pleasure to hear from you.

Corning means research in Glass

CORNING GLASS WORKS 10-6 Crystal St., Corning, N. Y

Jergens LIVE BUSHINGS

USE CARBIDE TOOLS TO FULL CAPACITY

INCREASE PRODUCTION—LOWER COSTS ON YOUR PRESENT EQUIPMENT

Illustrated above are a group of Jergens Live Roller Bearing Bushings with and without adapters designed to bring machine tools up to competitive levels. The Live Bushings illustrated above replace the bronze bearings in the column supports of various sizes and makes of Boring Mills. Utilizing two sets of absolutely sealed, adjustable, precision tapered roller bearings—these Jergens Live Bushings insure such constant rigidity and high precision that they permit the use of carbide tools to their full capacity giving heavier cuts at higher speeds with greater precision and longer tool life.

The liners of Jergens Live Bushings rotate with the bars preventing scoring and wearing of expensive boring bars. Every Jergens Live Bushing is made to the maximum bar capacity of the boring mill and can be easily "bushed-down" for precision adaption to any smaller size bar or combination of bars.

PERFORMANCE FEATURES

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- Greater overall length increases accuracy and bushing life
- Needle Bearings fill applications requiring closer center distances
- Bearings can be taken apart without removing housing
- Cartridge-type bearing holder provides greater accuracy
- Protects against thrust loads as well as radial
- Tapered bearings can be adjusted to compensate for wear
- Adaptable to receive removable slip bushings, keys or keyways

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IT IS ECONOMICAL, TOO — GOES 25% FURTHER, BECAUSE OF ITS WIDE SPREAD.

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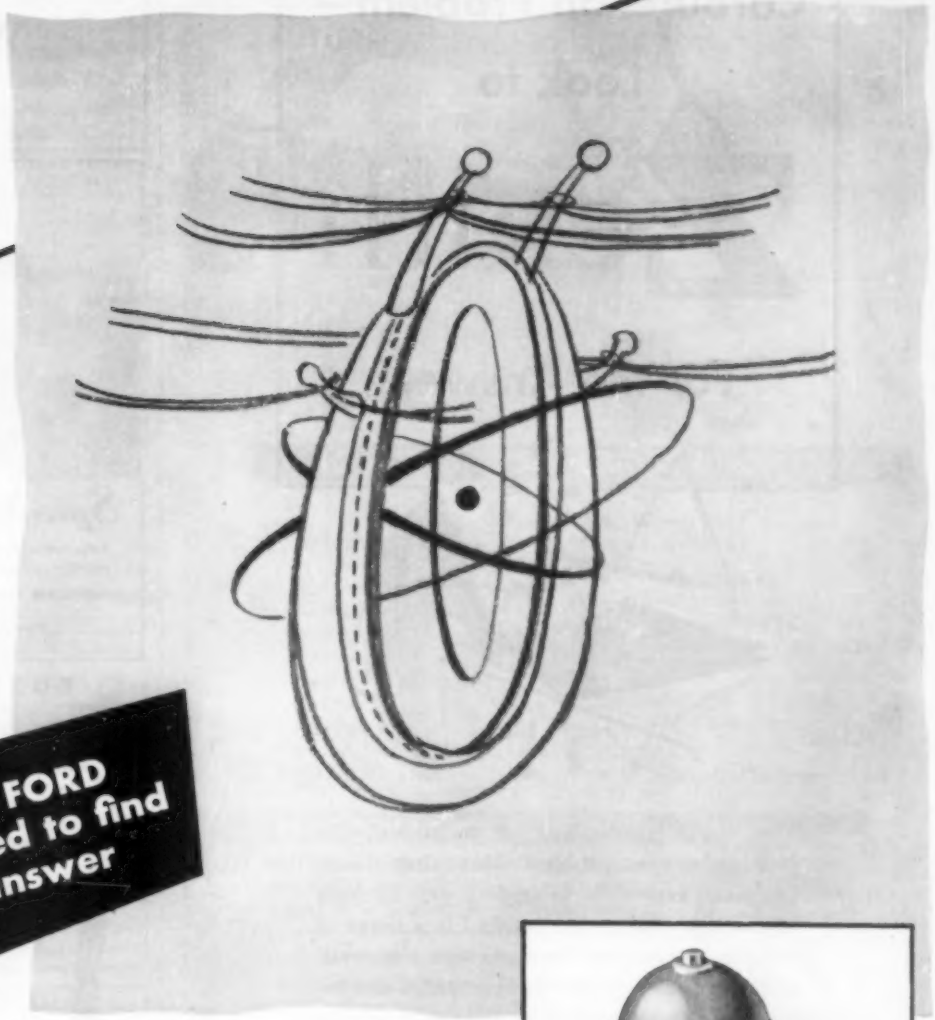
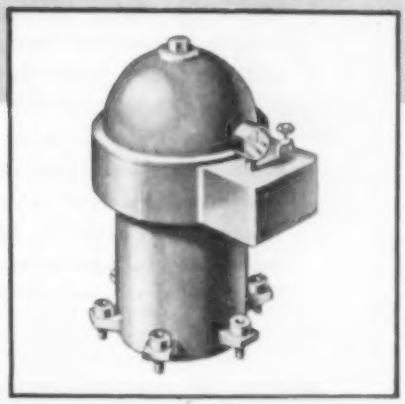
HOW TO MAKE A HARNESS
for an Atom



...and FORD was asked to find the answer



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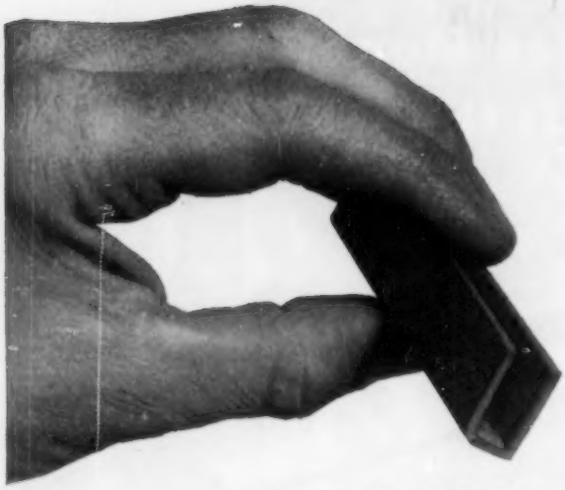

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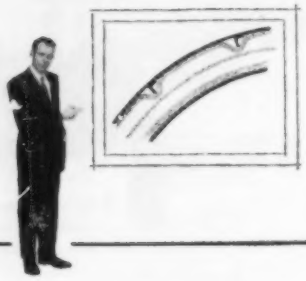

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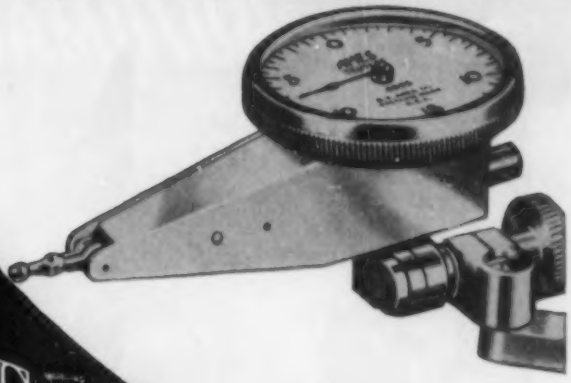

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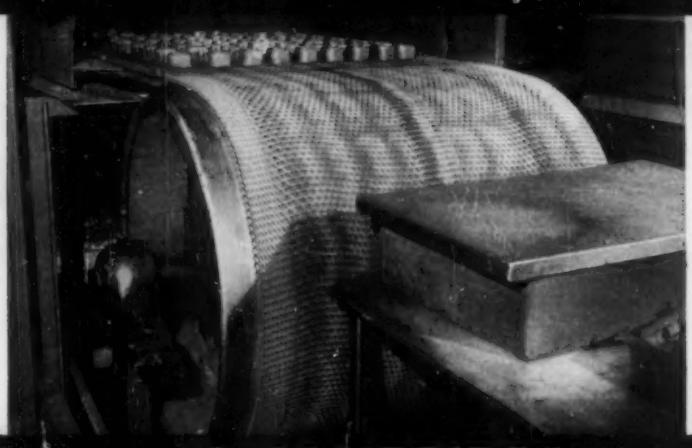

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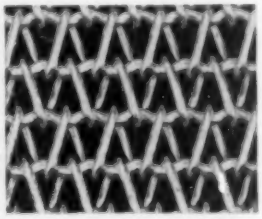

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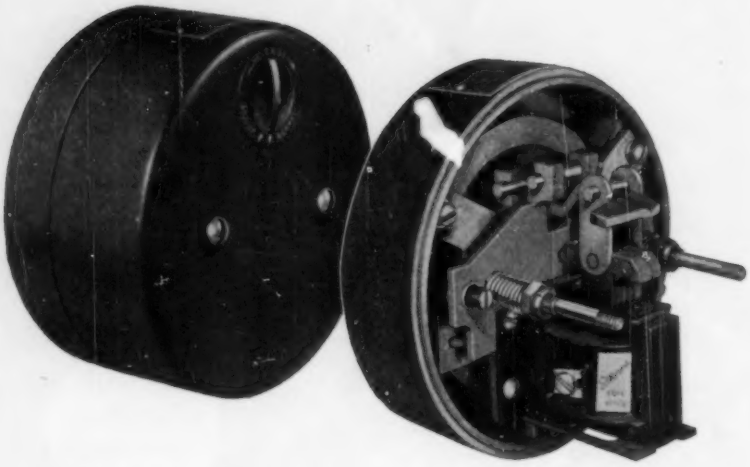

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Magnetic disc brakes for motors from 1/20 to 1/3 HP.

Stearns now offers you a line of magnetic disc brakes to meet the new NEMA frame standards in a horsepower range never before covered with this type of brake — the 1/20 hp. to 1/3 hp. range. Design engineers can now utilize the advantages of a spring-set, magnetically released brake in an entirely new field of motor applications.

This new *40 Series magnetic brake** is only 5 in. in diameter, less than 3-1/2 in. long, and has a torque range of from 6 lb. in. to 1 lb. ft. It is designed for mounting on the standard NEMA C end bell for motor frames 42-C and 48-C and is also available for floor mounting independent of motor. The brake incorporates all the design advantages which have made Stearns the preferred brake by the nation's leading motor manufacturers.

New! Magnetic disc brakes for re-rated motors—1/6 to 2 HP.

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Get all the facts about these new Stearns brakes that are broadening the field of magnetic disc brake applications. Write today for new descriptive literature.

1074

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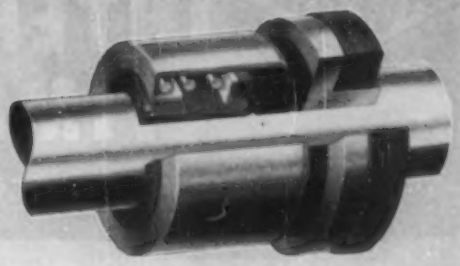
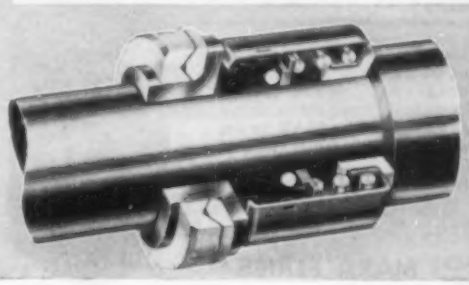
Garlock "Package" Seals
FOR ROTATING PUMP SHAFTS



Type BB-21A—Garlock Package Seal of standard construction with brass shell, brass washer, and Buna-N bellows.

	TYPE BB-21A	TYPE AA-21A
Liquids	For water, oils, alcohol, solvents (except aromatic, chlorinated and ketone types) and other liquids (except strong acids).	For very strong acids, oils, solvents (including aromatic, chlorinated and ketone types) and all other liquids.
Equipment	Rotating shafts of centrifugal pumps, process pumps, chemical pumps, agitators and similar applications.	
Sizes	For shafts from ⅜" to 3" diameters.	
Temperatures	With Buna-N bellows up to 212°; with silicone bellows up to 450° F.	Up to 450° F.
Pressures	Up to 150 p.s.i.	Up to 150 p.s.i.



Type AA-21A—Garlock Package Seal with hat-shaped "Teflon" drive ring, brass or 316 stainless steel shell and washer, "Teflon" 'O' ring, and "Teflon" two-piece vibration ring.

✓ CHECK THESE IMPORTANT FEATURES

- ☐ Occupy very small space
- ☐ Completely assembled—ready to install
- ☐ Proven performance at low cost
- ☐ Both types are dimensionally interchangeable

In both of these Package Seals, a leakless seal is provided by a positive contact between carefully lapped metal-to-carbon mating surfaces. All metal parts in both types are available in plated-brass, Ni-Resist, stainless steel with malcomized face, Garlock "B" iron, and others.

For complete details, ask your Garlock representative or write us about your sealing problems.

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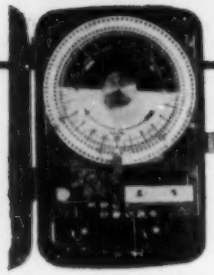

CYCLE MASTER TIME SWITCH

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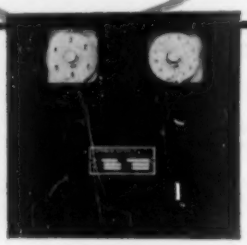
MAR SERIES INTERVAL TIMERS

AUTOMATIC RESET

This neat, compact, surface mounted unit measures 6⅜" x 3⅜" x 3⅞". Has an open or exposed type dial on which settings from a few seconds to maximum cycling time may be made. Exposed terminal block for connecting either 110 or 220 volt A. C. only. The MAR Series has a 10 amp. capacity and is available with delayed action, instant recycling if current is interrupted or hold position until current is restored.

AUTOMATIC RESET



MARA SERIES

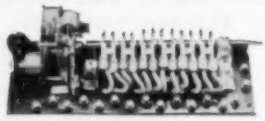
The MARA Series Timers can be supplied to operate in cycles from 10 seconds to 108 hours. In effect it is two interconnected adjustable Timers which permit varying not only the ON and OFF periods but also the length of the complete cycle. If either the open or closed circuit requires a short interval, one of the timers is provided with a very short time cycle for precise accuracy. Drawn steel case is 8" x 5" x 4½", has a lockable metal hasp and glass windows thru which dials are visible.

MANUAL RESET TIMER

MMR AND MR SERIES

A neat, compact low-cost unit for the accurate timing of a single operation, such as baking, defrosting, heat treating, etc. or for signaling purposes. Models are available in cycles from 60 seconds to 96 hours, with or without buzzer and bulls eye that visually and audibly signal end of cycle.

SEQUENCE TIMER



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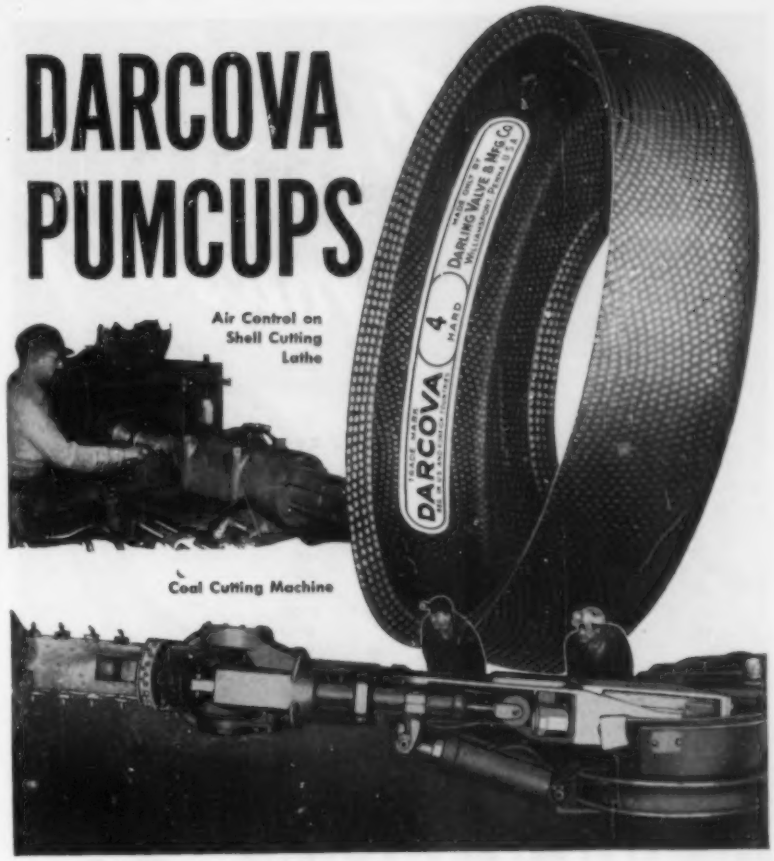
DARCOVA PUMCUPS



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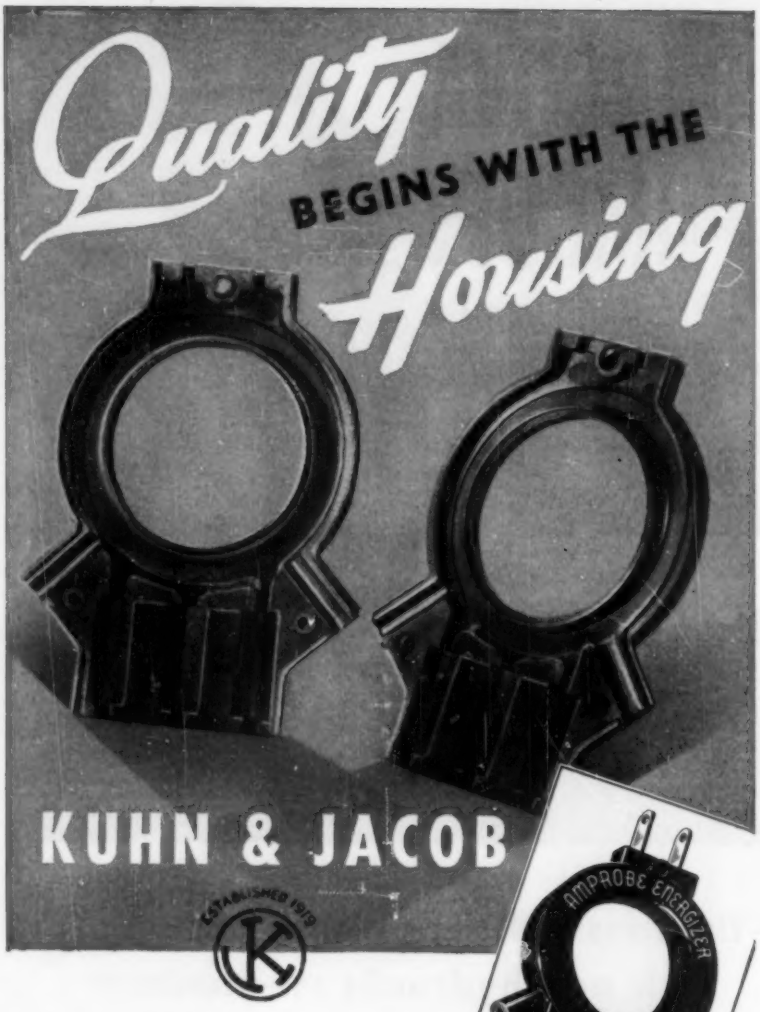

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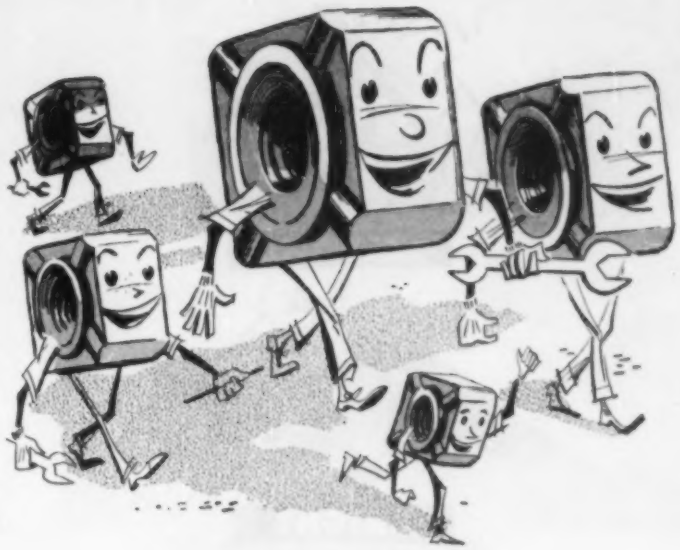

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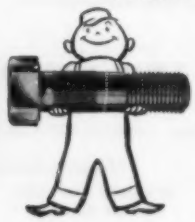

Exclusive New England Representatives for Cleveland Cap Screw Co.

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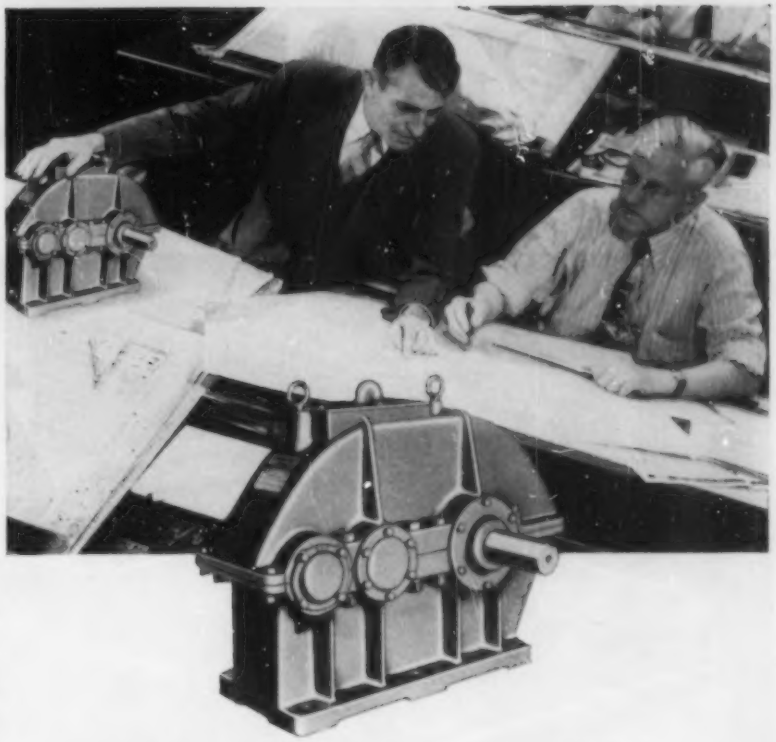

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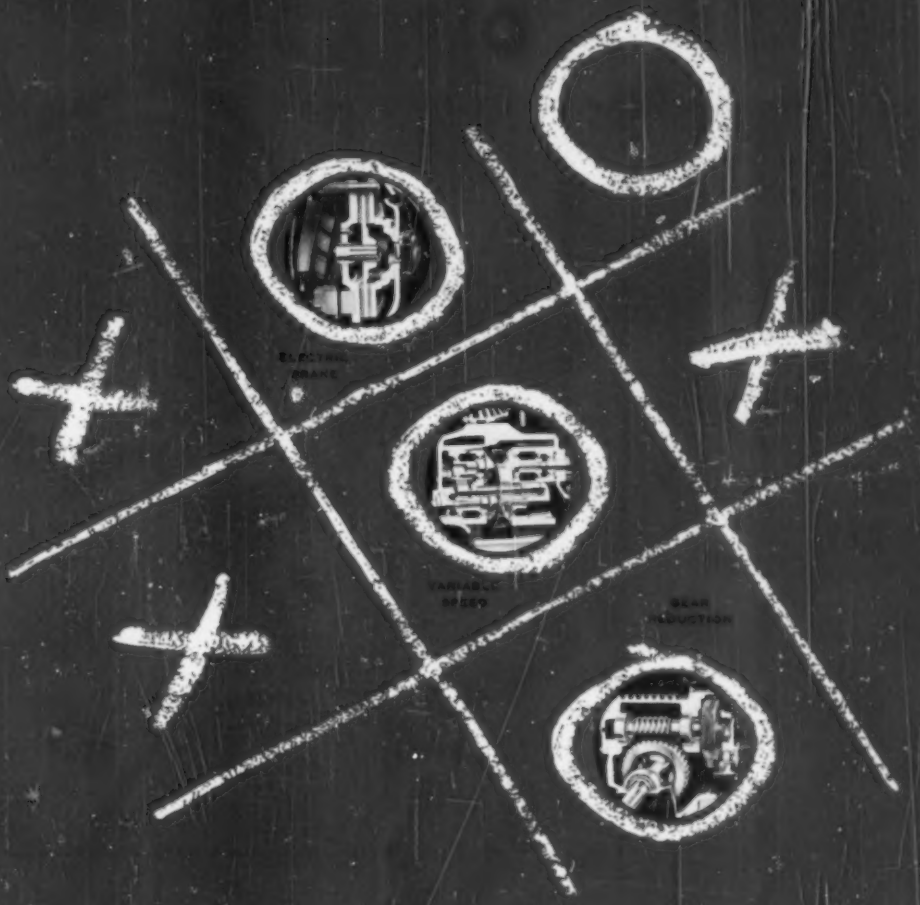

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